Proposed
Middle Columbia River Steelhead
Distinct Population Segment
ESA Recovery Plan

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Prepared by
National Marine Fisheries Service
Northwest Region

DISCLAIMER

Recovery plans delineate reasonable actions which the best available information indicates are necessary to recover and/or protect listed species. Plans are published by the National Marine Fisheries Service (NMFS), usually with the assistance of recovery teams, state agencies, local governments, salmon recovery boards, non-governmental organizations, interested citizens of the affected area, contractors, and others. Recovery plans do not necessarily represent the views, official positions, or approval of any individuals or agencies involved in the plan formulation, other than NMFS. They represent the official position of NMFS only after they have been signed by the Northwest Regional Administrator. Recovery plans are guidance and planning documents only; identification of an action to be implemented by any public or private party does not create a legal obligation beyond existing legal requirements. Nothing in this plan should be construed as a commitment or requirement that any Federal agency obligate or pay funds in any one fiscal year in excess of appropriations made by Congress for that fiscal year in contravention of the Anti-Deficiency Act, 31 U.S.C. 1341, or any other law or regulation. Approved recovery plans are subject to modification as dictated by new information, changes in species status, and the completion of recovery actions.

If areas of disagreement are identified between a management unit plan and the DPS plan, NMFS will work with the relevant parties to resolve the differences. NMFS reserves the right, however, to decide whether to incorporate any such material into the DPS plan.

Recovery plans provide important context for making determinations pursuant to section 7(a)(2) of the Endangered Species Act (ESA) by providing criteria that describe what "recovery" looks like. While providing context, recovery plans do not place any additional legal burden on NMFS or the action agency when determining whether an action would jeopardize the continued existence of a listed species or adversely modify critical habitat. The procedures for the section 7 consultation process are described in 50 CFR 402 and are applicable regardless of whether or not the actions are described in a recovery plan.

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ACRONYMS AND ABBREVIATIONS

A/P	abundance and productivity
AHA	All-H-Analyzer
BiOp	Biological Opinion
BOR	US Bureau of Reclamation
BPA	Bonneville Power Administration
BRT	Biological Review Team
CA	Comprehensive Analysis of Federal Columbia River Power System and Mainstem Effects of Upper Snake and Other Tributary Actions
CBFWA	Columbia Basin Fish & Wildlife Authority
COE	US Army Corps of Engineers
CWT	coded-wire-tagging
DPS	distinct population segment
EDT	Ecosystem Diagnosis and Treatment
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FCRPS	Federal Columbia River Power System
FERC	Federal Energy Regulatory Commission
FMEP	Fisheries Management and Evaluation Plan
FR	Federal Register
GIS	Geographic Information System
GNRO	Governor’s Natural Resources Office (Oregon)
GSRO	Governor's Salmon Recovery Office (Washington State)
HCP	Habitat Conservation Plan
HGMP	Hatchery and Genetic Management Plan
ICTRT	Interior Columbia Technical Recovery Team
LWD	large woody debris
MCSB	Middle Columbia Sounding Board (Oregon)
MPG	major population group
MSA	major spawning areas
N/A	Not Applicable
NGO	non-governmental organizations
NMFS	National Marine Fisheries Service
NWPCC	Northwest Power and Conservation Council
ODFW	Oregon Department of Fish and Wildlife
OPSW	Oregon Plan for Salmon and Watersheds
PRBC	Pelton-Round Butte Complex
RBH	Round Butte Hatchery
RM	river mile
SCA	Supplemental Comprehensive Analysis
SRSRB	Snake River Salmon Recovery Board
SS/D	spatial structure and diversity
TBD	To Be Determined
TRT	Technical Recovery Team
USFS	US Forest Service

USFWS	U.S. Fish and Wildlife Service
VSP	viable salmonid population
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
YBFWRB	Yakima Basin Fish and Wildlife Recovery Board
YN	Yakama Nation
YSPB	Yakima Subbasin Fish and Wildlife Planning Board

Recovery Planning Glossary

abundance: In the context of salmon recovery, unless otherwise qualified, abundance refers to the number of adult fish returning to spawn.

adaptive management: Adaptive management in salmon recovery planning is a method of decision making in the face of uncertainty. A plan for monitoring, evaluation, and feedback is incorporated into an overall implementation plan so that the results of actions can become feedback on design and implementation of future actions.

anadromous fish: Species that are hatched in freshwater, migrate to and mature in salt water, and return to freshwater to spawn.

baseline monitoring: In the context of recovery planning, baseline monitoring is done before implementation, in order to establish historical and/or current conditions against which progress (or lack of progress) can be measured.

biogeographical region: an area defined in terms of physical and habitat features, including topography and ecological variations, where groups of organisms (in this case, salmonids) have evolved in common.

broad sense recovery goals: Goals defined in the recovery planning process, generally by local recovery planning groups, that go beyond the requirements for delisting, to address, for example, other legislative mandates or social, economic, and ecological values.

compliance monitoring: Monitoring to determine whether a specific performance standard, environmental standard, regulation, or law is met.

delisting criteria: Criteria incorporated into ESA recovery plans that define both biological viability (biological criteria) and alleviation of the causes for decline (threats criteria based on the five listing factors in ESA section 4[a][1]), and that, when met, would result in a determination that a species is no longer threatened or endangered and can be proposed for removal from the Federal list of threatened and endangered species. These criteria are a NMFS determination and may include both technical and policy considerations.

distinct population segment (DPS): A listable entity under the ESA that meets tests of discreteness and significance according to USFWS and NMFS policy. A population is considered distinct (and hence a "species" for purposes of conservation under the ESA) if it is discrete from and significant to the remainder of its species based on factors such as physical, behavioral, or genetic characteristics, it occupies an unusual or unique ecological setting, or its loss would represent a significant gap in the species' range.

diversity: All the genetic and phenotypic (life history, behavioral, and morphological) variation within a population. Variations could include anadromy vs. lifelong residence in freshwater, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size,

developmental rate, ocean distribution patterns, male and female spawning behavior, physiology, molecular genetic characteristics, etc.

endangered species: A species in danger of extinction throughout all or a significant portion of its range.

effectiveness monitoring: Monitoring set up to test cause-and-effect hypotheses about recovery actions: Did the management actions achieve their direct effect or goal? For example, did fencing a riparian area to exclude livestock result in recovery of riparian vegetation?

ESA recovery plan: A plan to recover a species listed as threatened or endangered under the U.S. Endangered Species Act (ESA). The ESA requires that recovery plans, to the extent practicable, incorporate (1) objective, measurable criteria that, when met, would result in a determination that the species is no longer threatened or endangered; (2) site-specific management actions that may be necessary to achieve the plan's goals; and (3) estimates of the time required and costs to implement recovery actions.

evolutionarily significant unit (ESU): A group of Pacific salmon or steelhead trout that is (1) substantially reproductively isolated from other conspecific units and (2) represents an important component of the evolutionary legacy of the species.

extinct: No longer in existence. No individuals of this species can be found.

extirpated: Locally extinct. Other populations of this species exist elsewhere. The ICTRT considers extirpated steelhead populations to be those that are entirely cut off from anadromy, such as the Crooked River population. Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough fish or habitat in suitable condition to support a fully functional population.

factors for decline: Five general categories of causes for decline of a species, listed in the Endangered Species Act section 4(a)(1)(b): (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or human-made factors affecting its continued existence.

functionally extirpated: Describes a species that has been extirpated from an area; although a few individuals may occasionally be found, there are not enough fish or habitat in suitable condition to support a fully functional population.

hyporheic zone: Area of saturated gravel and other sediment beneath and beside streams and rivers where groundwater and surface water mix.

implementation monitoring: Monitoring to determine whether an activity was performed and/or completed as planned.

independent population: Any collection of one or more local breeding units whose population dynamics or extinction risk over a 100-year time period is not substantially altered by exchanges of individuals with other populations.

indicator: A variable used to forecast the value or change in the value of another variable.

interim regional recovery plan: A recovery plan that is intended to lead to an ESA recovery plan but that is not yet complete. These plans might address only a portion of an ESU or lack other key components of an ESA recovery plan.

intrinsic potential: The estimated relative suitability of a habitat for spawning and rearing of anadromous salmonid species under historical conditions inferred from stream characteristics including channel size, gradient, and valley width.

intrinsic productivity: The expected ratio of natural-origin offspring to parent spawners at levels of abundance below carrying capacity.

kelts: Steelhead that are returning to the ocean after spawning and have the potential to spawn again in subsequent years (unlike most salmon, steelhead do not necessarily die shortly after spawning).

large woody debris (LWD): A general term for wood naturally occurring or artificially placed in streams, including branches, stumps, logs, and logjams. Streams with adequate LWD tend to have greater habitat diversity, a natural meandering shape, and greater resistance to flooding.

legacy effects: Impacts from past activities that continue to affect a stream or watershed in the present day.

limiting factor: Physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) experienced by the fish that result in reductions in viable salmonid population (VSP) parameters (abundance, productivity, spatial structure, and diversity). Key limiting factors are those with the greatest impacts on a population's ability to reach a desired status.

locally developed recovery plan: A plan developed by state, tribal, regional, or local planning entities to address recovery of a species. These plans are being developed by a number of entities throughout the region to address ESA as well as state, tribal, and local mandates and recovery needs.

maintained status: Population status in which the population does not meet the criteria for a viable population but does support ecological functions and preserve options for ESU/DPS recovery.

major population group (MPG): A group of salmonid populations that are geographically and genetically cohesive. The MPG is a level of organization between demographically independent populations and the ESU or DPS.

management unit: A geographic area defined for recovery planning purposes on the basis of state, tribal or local jurisdictional boundaries that encompass all or a portion of the range of a listed species, ESU, or DPS.

metrics: A metric is something that quantifies a characteristic of a situation or process; for example, the number of natural-origin salmon returning to spawn to a specific location is a metric for population abundance.

morphology: The form and structure of an organism, with special emphasis on external features.

natural-origin fish: Fish that were spawned and reared in the wild, regardless of parental origin.

parr: The stage in anadromous salmonid development between absorption of the yolk sac and transformation to smolt before migration seaward.

phenotype: Any observable characteristic of an organism, such as its external appearance, development, biochemical or physiological properties, or behavior.

piscivorous: (Adj.) Describes fish that eat other fish.

productivity: The average number of surviving offspring per parent. Productivity is used as an indicator of a population's ability to sustain itself or its ability to rebound from low numbers. The terms "population growth rate" and "population productivity" are interchangeable when referring to measures of population production over an entire life cycle. Can be expressed as the number of recruits (adults) per spawner or the number of smolts per spawner.

recovery domain: An administrative unit for recovery planning defined by NMFS based on ESU boundaries, ecosystem boundaries, and existing local planning processes. Recovery domains may contain one or more listed ESUs.

recovery goals: Goals incorporated into a locally developed recovery plan, which may include delisting (i.e. no longer considered endangered or threatened), reclassification (e.g., from endangered to threatened), and/or other goals. Broad sense goals are a subset of recovery goals (see glossary entry above).

recovery plan supplement: A NMFS supplement to a locally developed recovery plan that describes how the plan addresses ESA requirements for recovery plans. The supplement also proposes ESA delisting criteria for the ESUs addressed by the plan, since a determination of these criteria is a NMFS decision.

recovery scenarios: Scenarios that describe a target status for each population within an ESU, generally consistent with TRT recommendations for ESU viability.

redd: A nest constructed by female salmonids in streambed gravels where eggs are fertilized and deposited.

recovery strategy: Statements that identify the assumptions and logic – the rationale – for the species' recovery program.

riparian area: Area with distinctive soils and vegetation between a stream or other body of water and the adjacent upland.

salmonid: Fish of the family *Salmonidae*, including salmon, trout, chars, grayling, and whitefish. In general usage, the term usually refers to salmon, trout, and chars.

smolt: A juvenile salmonid that is undergoing physiological and behavioral changes to adapt from freshwater to saltwater as it migrates toward the ocean.

spatial structure: Characteristics of a fish population's geographic distribution. Current spatial structure depends upon the presence of fish, not merely the potential for fish to occupy an area.

stakeholders: Agencies, groups, or private citizens with an interest in recovery planning, or who will be affected by recovery planning and actions.

Technical Recovery Team (TRT): Teams convened by NMFS to develop technical products related to recovery planning. TRTs are complemented by planning forums unique to specific states, tribes, or regions, which use TRT and other technical products to identify recovery actions.

threatened species: A species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

threats: Human activities or natural events (e.g., road building, floodplain development, fish harvest, hatchery influences, volcanoes) that cause or contribute to limiting factors. Threats may exist in the present or be likely to occur in the future.

viability criteria: Criteria defined by NMFS-appointed Technical Recovery Teams to describe a viable salmonid population, based on the biological parameters of abundance, productivity, spatial structure, and diversity. These criteria are used as technical input into the recovery planning process and provide a technical foundation for development of biological delisting criteria.

viability curve: A curve describing combinations of abundance and productivity that yield a particular risk of extinction at a given level of variation over a specified time frame.

viable salmonid population (VSP): an independent population of Pacific salmon or steelhead trout that has a negligible risk of extinction over a 100-year time frame.

VSP parameters: Abundance, productivity, spatial structure, and diversity. These describe characteristics of salmonid populations that are useful in evaluating population viability. See

NOAA Technical Memorandum NMFS-NWFSC-42, *Viable salmonid populations and the recovery of evolutionarily significant units* (McElhany et al. 2000).

EXECUTIVE SUMMARY

Introduction

This is a recovery plan (Plan) for the protection and restoration of Middle Columbia River steelhead (*Oncorhynchus mykiss*), which spawn and rear in tributaries to the Columbia River in central and eastern Washington and Oregon (Figure ES-1). The Middle Columbia River steelhead distinct population segment (DPS) was listed as threatened under the Endangered Species Act of 1973 (ESA) on January 5, 2006 (71 FR 834).

Section 4(f) of the ESA requires NOAA's National Marine Fisheries Service (NMFS) to develop recovery plans for marine species listed under the Act. Recovery plans identify actions needed to restore threatened and endangered species to the point that they are again self-sustaining elements of their ecosystems and no longer need the protections of the ESA. Although recovery plans are guidance, not regulatory documents, the ESA clearly envisions recovery plans as the central organizing tool for guiding each species' recovery process. Recovery planning is an opportunity to search for the common ground, to organize protection and restoration of salmonid habitat, and to secure the economic and cultural benefits that accrue to human communities from healthy watersheds and rivers.

Eighteen of the 33 salmon and steelhead species in the Northwest region are listed as threatened or endangered. The Middle Columbia steelhead is among those with the best prospects of recovery, although it will require considerable political will and investment of long-term effort and funding. Modeling of the potential effects of the actions that are proposed in this plan (see Chapter 9) predicts that the DPS can achieve a "negligible" risk of extinction within a reasonable time frame – e.g. 25 to 50 years – if the actions are taken and if they have the predicted effects on steelhead habitat and survival. Cautious though this statement may be, it is a beacon of hope in the complex realm of salmonid recovery in the Northwest. The following sections tell the story.

ESA Requirements

ESA section 4(a)(1) lists factors for re-classification or delisting that are to be addressed in recovery plans:

A. The present or threatened destruction, modification, or curtailment of [the species'] habitat or range
B. Over-utilization for commercial, recreational, scientific or educational purposes
C. Disease or predation
D. The inadequacy of existing regulatory mechanisms
E. Other natural or human-made factors affecting its continued existence

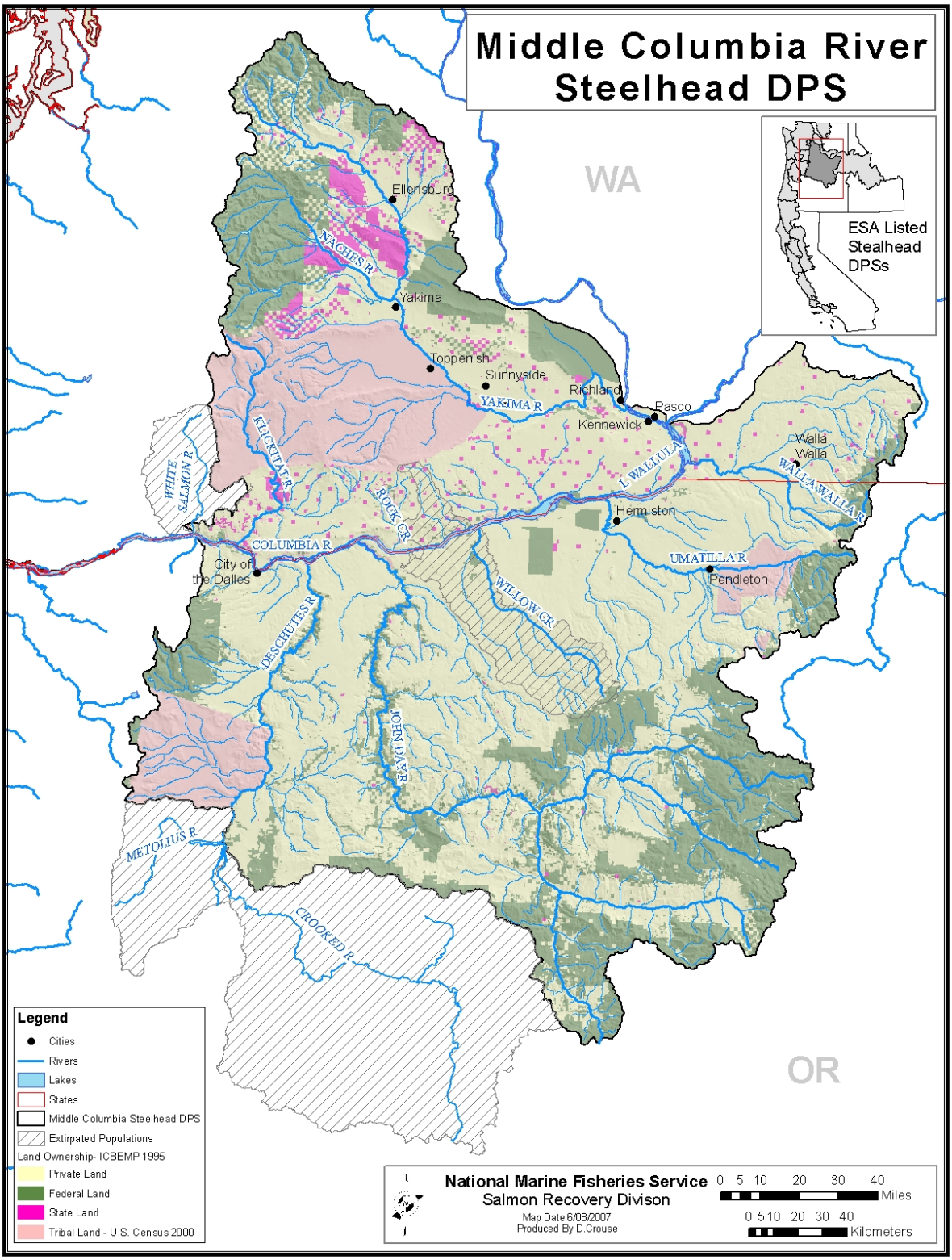


Figure ES-1. Geographic boundaries of the Middle Columbia River Steelhead DPS, showing land ownership.

ESA section 4(f)(1)(B) directs that recovery plans, to the extent practicable, incorporate:

1. a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;
2. objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this chapter, that the species be removed from the list; and;
3. estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

In addition, it is important for recovery plans to provide the public and decision makers with a clear understanding of the goals and strategies needed to recover a listed species and the science underlying these conclusions (NMFS Interim Recovery Planning Guidance, October 2004).

Once a species is deemed recovered and therefore removed from a listed status, section 4(g) of the ESA requires the monitoring of the species for a period of not less than 5 years to ensure that it retains its recovered status.

Steelhead Distribution and Life History

The spawning range of the Middle Columbia steelhead DPS extends over an area of approximately 35,000 square miles in the Columbia plateau of eastern Washington and eastern Oregon. The DPS includes all naturally spawned populations of steelhead in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding steelhead from the Snake River Basin (64 FR 14517; 71 FR 849). The Cascade Mountains form the western border of the plateau in both Oregon and Washington, while the Blue Mountains form the eastern edge. The southern border is marked by the divides that separate the upper Deschutes and John Day basins from the Oregon High Desert and drainages to the south. The Wenatchee Mountains and Palouse areas of eastern Washington border the Middle Columbia on the north.

Most of the region is privately owned (64 percent), with the remaining area under Federal (23 percent), tribal (10 percent) and state (3 percent) ownership (Figure ES-1). Most of the landscape consists of rangeland and timberland, with significant concentrations of dryland agriculture in parts of the range. Irrigated agriculture and urban development are generally concentrated in valley bottoms. Human populations in these regions are growing.

Four artificial propagation programs are considered part of the DPS: the Touchet River Endemic Summer Steelhead Program, the Yakima River Kelt Reconditioning Program, and the Umatilla River and Deschutes River steelhead hatchery programs.

The species *Oncorhynchus mykiss* exhibits perhaps the most complex suite of life history traits of any species of Pacific salmonid. These fish can be anadromous (migratory) or freshwater residents (and under some circumstances, apparently yield offspring of the opposite form). Steelhead can spawn more than once (iteroparous), whereas all other *Oncorhynchus* except cutthroat trout (*O. clarki*) spawn once and then die (semelparous).

Within the range of West Coast steelhead, spawning migrations occur throughout the year, with seasonal peaks of activity. The "runs" are usually named for the season in which the peak occurs. Most steelhead can be categorized as one of two run types, based on their sexual maturity when they re-enter freshwater and how far they go to spawn. In the Pacific Northwest, summer steelhead enter freshwater between May and October and require several months to mature before spawning; winter steelhead enter freshwater between November and April with well-developed gonads and spawn shortly thereafter. Summer steelhead usually spawn farther upstream than winter steelhead (Withler 1966; Roelofs 1983; Behnke 1992).

The Middle Columbia River steelhead DPS includes populations of inland winter steelhead in the Klickitat River, White Salmon River, Fifteenmile Creek, and possibly Rock Creek.

Relationship of Steelhead DPS to Resident *O. mykiss*

"Steelhead" is the name commonly applied to the anadromous (migratory) form of the biological species *Oncorhynchus mykiss*. The common name of the non-anadromous, or resident, form is rainbow trout. When NMFS originally listed the Middle Columbia River steelhead as threatened on March 25, 1999 (64 FR 14517), it was classified as an "evolutionarily significant unit" (ESU) of salmonids that included both the anadromous and resident forms. Recently, NMFS revised its species determinations for West Coast steelhead under the ESA, delineating anadromous, steelhead-only "distinct population segments" (DPS). NMFS listed the Middle Columbia River steelhead DPS as threatened on January 5, 2006 (71 FR 834). Rainbow trout are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). This recovery plan addresses steelhead and not rainbow trout, as is consistent with the 2006 ESA listing decision.

Context of Plan Development

While NMFS is directly responsible for ESA recovery planning for salmon and steelhead, NMFS believes that ESA recovery plans for salmon and steelhead should be based on the many state, regional, tribal, local, and private conservation efforts already underway throughout the region. Local support of recovery plans by those whose activities directly affect the listed species, and whose actions will be most affected by recovery efforts, is essential. NMFS therefore supports and participates in locally led collaborative efforts to develop recovery plans that involve local communities, state, tribal, and Federal entities, and other stakeholders.

This Plan is the product of a collaborative process initiated by NMFS with assistance from the Middle Columbia Forum (Mid-C Forum), a bi-state, tri-tribe group convened by NMFS to provide input on the development of the DPS recovery plan. NMFS developed this Plan by drawing upon the best available scientific information provided by the six regional recovery plans included as appendices to this Plan (i.e. the management unit plans, described below and in Section 1.6.), and by a regional team of scientists (the Interior Columbia Technical Recovery Team, described below). The draft plan went through repeated reviews and revisions in response to comments from both the scientific team and the Mid-C Forum. Participants in the Mid-C Forum include the Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), the Yakama Nation, Confederated Tribes of the Warm Springs Indian Reservation, Confederated Tribes of the Umatilla Indian Reservation, Washington Governor's Salmon Recovery Office, Oregon Governor's Natural Resources Office, Snake River Salmon Recovery Board, Yakima Basin Fish and Wildlife Recovery Board, US Bureau of

Reclamation (BOR), US Fish and Wildlife Service (USFWS), US Forest Service (USFS), US Army Corps of Engineers (COE), Klickitat County, and NMFS Northwest Region.

Tribal Trust and Treaty Responsibilities

Northwest Indian Tribes have legally enforceable treaty rights reserving to them a share of the salmon harvest. A complex history of treaties, executive orders, legislation, and court decisions have culminated in the recognition of tribes as co-managers who share management responsibilities and rights for fisheries in the Columbia Basin.

Ensuring a sufficient abundance of salmon and steelhead to sustain harvest is an important element in fulfilling trust responsibilities and treaty rights as well as garnering public support for recovery plans. ESA and tribal trust responsibilities complement one another. Both depend on a steady upward trend toward ESA recovery and delisting in the near term, while making aquatic habitat, harvest, and land management improvements for the long-term.

Recovery Domains and Technical Recovery Teams

Currently, there are 18 ESA-listed ESUs/DPSs of Pacific salmon and steelhead in the Pacific Northwest. For the purpose of recovery planning for these species, NMFS Northwest Region designated five geographically based "recovery domains" (Figure ES-2). The range of the Middle Columbia River steelhead DPS is located in the Middle Columbia sub-domain of the Interior Columbia domain.

For each domain, NMFS appointed a team of scientists, nominated for their geographic and species expertise, to provide a solid scientific foundation for recovery plans. The charge of each Technical Recovery Team (TRT) is to define ESU/DPS structures, develop recommendations on biological viability criteria for each ESU or DPS and its component populations, provide scientific support to local and regional recovery planning efforts, and provide scientific evaluations of proposed recovery plans. The Interior Columbia TRT (ICTRT) includes biologists from NMFS, states, and academic institutions.

Viable Salmonid Populations

All the TRTs used the same biological principles for developing their recommendations for ESU/DPS and population viability criteria – criteria that may be used, along with criteria based on mitigation of the factors for decline, in determining whether a species has recovered sufficiently to be downlisted or delisted. These principles are described in a NMFS technical memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000).

Viable salmonid populations (VSP) are defined in terms of four parameters: abundance, productivity or growth rate, spatial structure, and diversity. A viable ESU/DPS is naturally self-sustaining, with a high probability of persistence over a 100-year time period. Each TRT made recommendations using the VSP framework, based on data availability, the unique biological characteristics of the ESUs/DPSs and habitats in the domain, and the members' collective

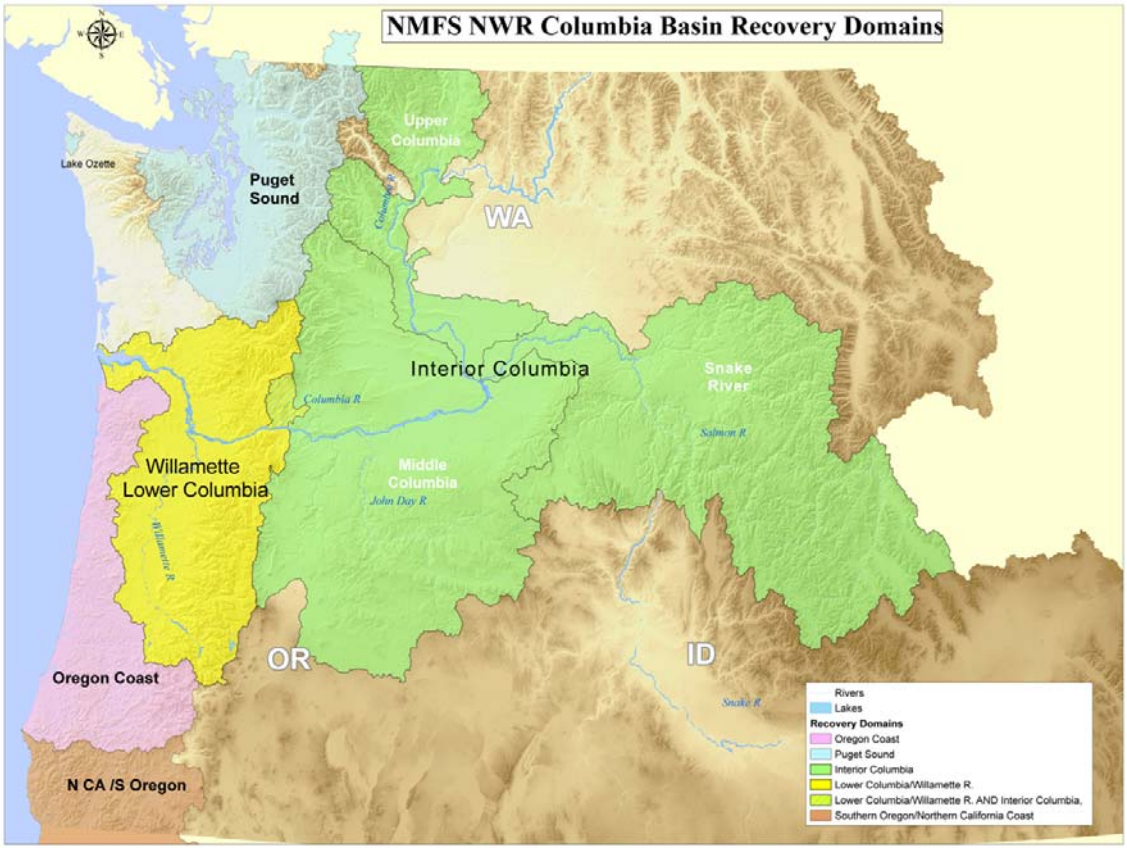


Figure ES-2. Columbia Basin Recovery Domains for NMFS Northwest Region

experience and expertise. Although NMFS has encouraged the TRTs to develop regionally specific approaches for evaluating viability and identifying factors limiting recovery, all the TRTs are working from a common scientific foundation. Viability criteria are an important part of recovery goals, as described later in this summary.

Management Units

In each domain, NMFS worked with state, tribal, local, and other Federal entities to develop planning forums that build to the extent possible on ongoing, locally led recovery efforts. NMFS defined "management units" based on jurisdictional boundaries as well as areas where local planning efforts were underway (Figure ES-3). The Middle Columbia management units are (1) Oregon; (2) Washington Gorge, which, in turn, is subdivided into three planning areas, White Salmon, Klickitat, and Rock Creek; (3) Yakima subbasin; and (4) Southeast Washington.

Management Unit Recovery Plans

Although NMFS has prepared this plan for the entire DPS, the DPS plan's component parts (the management unit plans, Appendices A-F) are the work of local groups and county, state, Federal, and tribal entities within the Middle Columbia River region on both sides of the river.

- **Oregon Management Unit:** ***Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment (Oregon Steelhead Recovery Plan) (Appendix A).***

The Oregon Department of Fish and Wildlife (ODFW) is the lead for the Oregon Steelhead Recovery Plan. ODFW drew together three groups to help with the plan: the Middle Columbia Recovery Planning Team, made up of ODFW staff biologists and representatives from eight state natural resource agencies; a planning forum, the Middle Columbia Sounding Board, made up of representatives of local communities, agricultural water users, Federal and non-Federal land managers, governing bodies, tribes, and industry and environmental interests; and an Expert Panel of 12 biologists to examine limiting factors and threats for the 10 independent steelhead populations in Oregon.

- **Washington Gorge Management Unit:** ***Recovery Plans for the Klickitat (Appendix B), Rock Creek (Appendix C), and White Salmon (Appendix D) subbasin populations of Middle Columbia River steelhead***

Since there is not presently a Washington State sponsored salmon recovery planning board for this area, NMFS staff drafted the three plans in collaboration with the Yakama Nation, Washington Department of Fish and Wildlife, Klickitat County, the Washington State Governor's Salmon Recovery Office, other Federal agencies, state agencies, local governments, and the public.

- **Yakima Management Unit:** ***Yakima Steelhead Recovery Plan (Appendix E)***

The Yakima Basin Fish and Wildlife Recovery Board (YBFWRB), which includes representatives from the Yakama Nation, Benton, Kittitas, and Yakima counties, and 18 of the 24 municipalities in the Yakima Basin, developed the Yakima Basin Steelhead Recovery Plan (available at www.ybfwrb.org).

- **Southeast Washington Management Unit:** ***Snake River Salmon Recovery Plan for Southeast Washington (Appendix F)***

The Snake River Salmon Recovery Board developed the Southeast Washington Recovery Plan. The Board consists of representatives of the Confederated Tribes of the Umatilla Indian Reservation; a county commissioner and citizen representative from Asotin, Columbia, Garfield, Walla Walla and Whitman counties; a land owner representative from Asotin, Columbia and Garfield counties; and the Walla Walla county irrigation district, The Board appointed a Regional Technical Team for technical and scientific assistance.

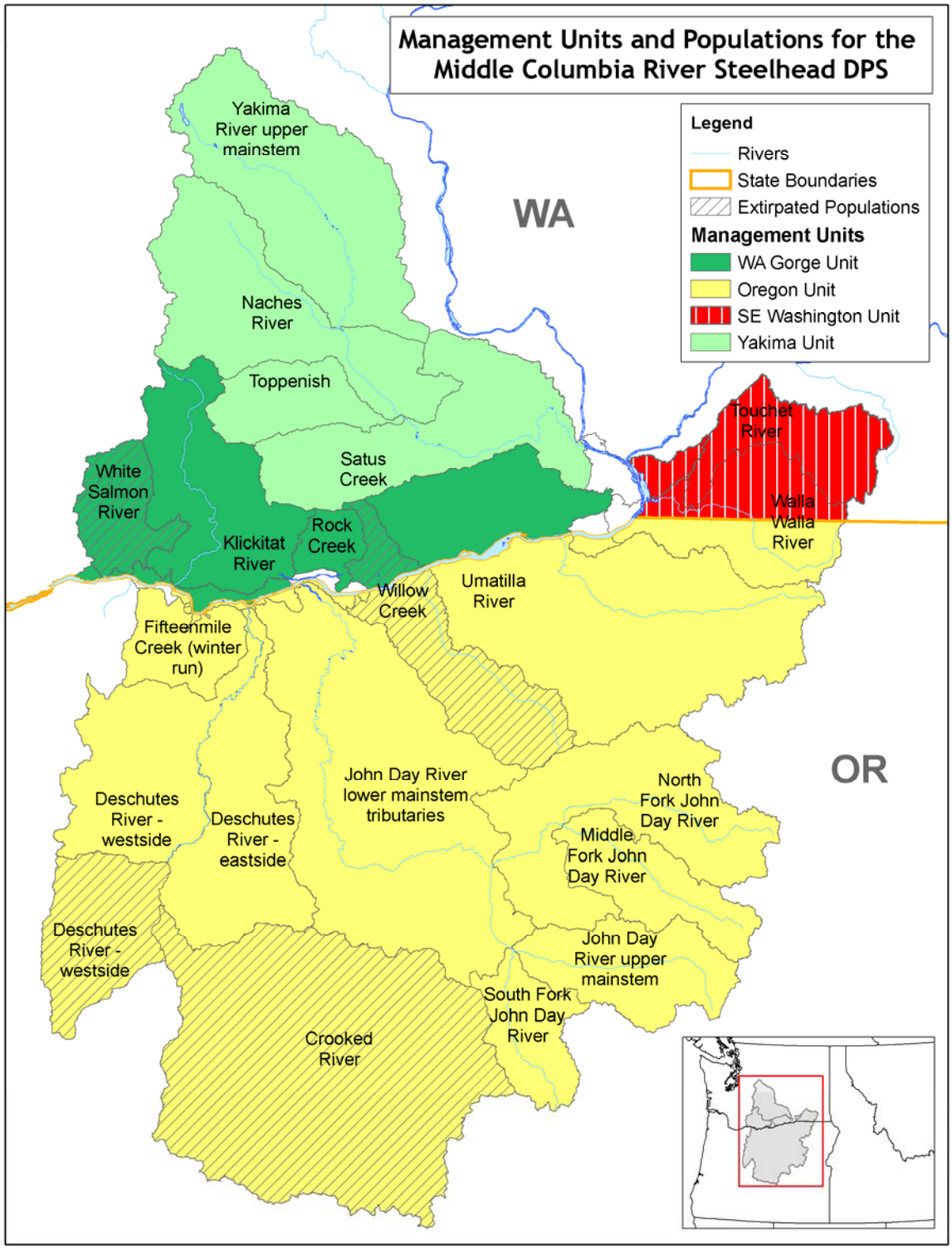


Figure ES-3. Management Units and Populations for the Middle Columbia River Steelhead DPS

Important Concepts in Steelhead (and Salmon) Biology

Salmonid species' homing propensity (their tendency to return to the locations where they originated) creates unique patterns of genetic variation and connectivity that mirror the distribution of their spawning areas across the landscape. Diverse genetic, life history, and morphological characteristics have evolved over generations, creating runs highly adapted to diverse environments. It is this variation that gives the species as a whole the resilience to persist over time.

Historically, a salmon ESU or steelhead DPS typically contained multiple populations connected by some small degree of genetic exchange by straying spawners. Thus, the overall biological structure of the ESU/DPS is hierarchical; spawners in the same area of the same stream will share more characteristics than those in the next stream over. Fish whose natal streams are separated by hundreds of miles will have less genetic similarity.

Definition of Evolutionarily Significant Units/Distinct Population Segments

An ESU or DPS is a distinctive group of Pacific salmon or steelhead that is uniquely adapted to a particular area or environment and cannot be replaced. Because of the hierarchical structure of salmonid populations, the concept of "distinctive group" has received considerable attention and refinement. An ESU is defined as a group of Pacific salmon that is "substantially reproductively isolated from other conspecific units and represents an important component of the evolutionary legacy of the species" (Waples 1991). A "population segment" is considered distinct (a DPS and hence a "species" for purposes of conservation under the ESA) if it is discrete from and significant to the remainder of its species based on factors such as physical, behavioral, or genetic characteristics; it occupies an unusual or unique ecological setting; or its loss would represent a significant gap in the species' range.

ESUs/DPSs may contain multiple populations that are connected by some degree of genetic exchange through "straying," and hence may have a broad geographic range across watersheds and river basins.

Major Population Groups

Within an ESU/DPS, independent populations can be grouped into larger populations that share similar genetic, geographic, and/or habitat characteristics (McClure et al. 2003). These "major groupings" of populations (MPGs) are isolated from one another over a longer time scale than that defining the individual populations, but retain some degree of connectivity greater than that between ESUs/DPSs.

Independent Populations

McElhany et al. (2000) defined an independent population as follows:

> *"…a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season."*

Abundance and Productivity

Abundance refers to spawners (adults on the spawning ground), measured over a time series, i.e. some number of years. The ICTRT often uses a recent 10- or 12-year geometric mean of natural spawners as a measure of current abundance.

The productivity of a population (the average number of surviving offspring per parent) is a measure of the population's ability to sustain itself. Productivity can be measured as spawner:spawner ratios (returns per spawner or recruits per spawner) (or adult progeny to parent), annual population growth rate, or trends in abundance. Population-specific estimates of abundance and productivity are derived from time series of annual estimates, typically subject to a high degree of annual variability and sampling-induced uncertainties.

Abundance and productivity are linked, as populations with low productivity can still persist if they are sufficiently large, and small populations can persist if they are sufficiently productive. A viable population needs sufficient abundance to maintain genetic health and to respond to normal environmental variation, and sufficient productivity to enable the population to quickly rebound from periods of poor ocean conditions or freshwater perturbations.

Spatial Structure and Diversity

Spatial structure and diversity considerations are combined in the evaluation of a salmonid population's status because they often overlap. A population's spatial structure is made up of both the geographic distribution of individuals in the population and the processes that generate that distribution (McElhany et al. 2000, p. 18). Diversity refers to the distribution of traits within and among populations. Some traits are completely genetically based, while others, including nearly all morphological, behavioral, and life history traits, vary as a result of a combination of genetic and environmental factors (ibid., p. 19).

Populations with restricted distribution and few spawning areas are at a higher risk of extinction as a result of catastrophic environmental events, such as a landslide, than are populations with more widespread and complex spatial structures. Population-level diversity is similarly important for long-term persistence. Populations exhibiting greater diversity are generally more resilient to short-term and long-term environmental changes.

Middle Columbia Steelhead Populations and Major Population Groups

The ICTRT (McClure et al. 2003) identified 20 historical populations of Middle Columbia steelhead, shown in Figure ES-4. This identification was based on genetic information, geography, life history traits, morphological traits, and population dynamics. Seventeen of these populations are extant, and three extirpated (White Salmon River, Deschutes Crooked River above Pelton Dam, and Willow Creek).

The ICTRT stratified the Middle Columbia River steelhead populations into MPGs based on ecoregion characteristics, life history types, and other geographic and genetic considerations. It identified four MPGs: Cascades Eastern Slope Tributaries, Yakima Basin, John Day Basin, and Umatilla/Walla Walla. The John Day Basin MPG is wholly within Oregon and the Yakima Basin

MPG is wholly within Washington. The other two include populations on both sides of the Oregon/Washington boundary.

Population Size

Middle Columbia steelhead spawn in a wide range of tributary drainage areas, from small creeks, e.g. Fifteenmile Creek or Rock Creek, to very large rivers, such as the Lower John Day. The ICTRT categorized historical population sizes as Basic, Intermediate, Large, and Very Large, and set minimum abundance thresholds for viable steelhead populations of each type (ICTRT 2007a and 2007b). The abundance thresholds are associated with minimum productivity thresholds. Abundance and productivity are linked, within limits; above a certain threshold, higher productivity can compensate for lower abundance and vice versa. Table ES-1 shows the minimum abundance and productivity thresholds for the Middle Columbia steelhead populations to have a 95 percent probability of persistence for the next 100 years.

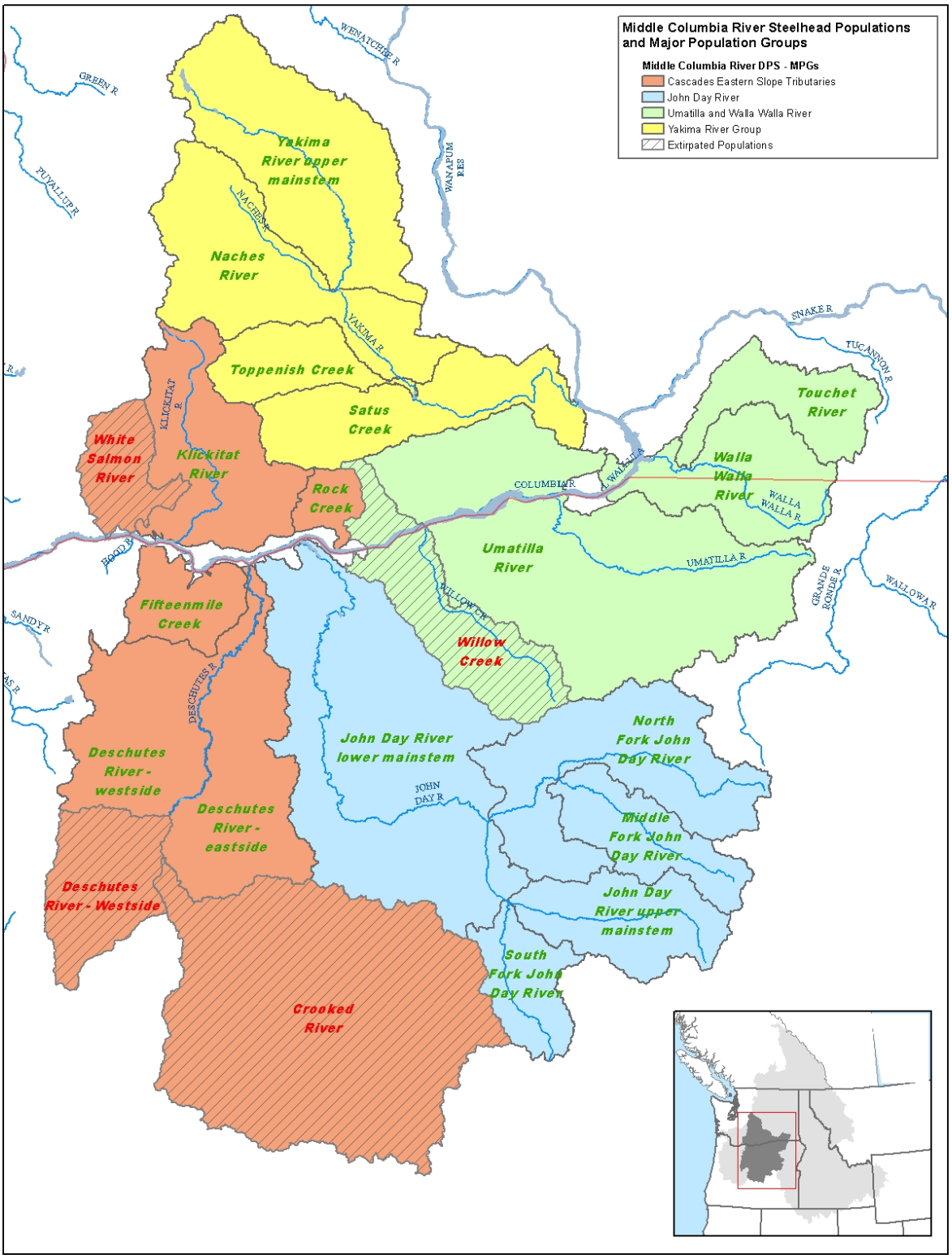


Figure ES-4. Middle Columbia River Steelhead Populations and Major Population Groups.

Table ES-1. Middle Columbia steelhead size categories (ICTRT 2007a)

Major Population Grouping	Population	Population Size	Abundance Threshold	Productivity Threshold
Cascades Eastern Slope Tributaries	White Salmon (functionally extirp.)	Basic	500	1.56
	Klickitat R.	Intermediate	1000	1.35
	Fifteenmile Cr.	Basic	500	1.56
	Deschutes R. East	Intermediate	1000	1.35
	Deschutes R. West	Large[1]	1500	1.26
	Rock Cr.	Basic	500	1.56
	Crooked River (Extirp.)	Very Large	2250	1.19
John Day River	Lower Mainstem JD	Very Large	2250	1.19
	North Fork John Day	Large	1500	1.26
	Middle Fork John Day	Intermediate	1000	1.35
	South Fork John Day	Basic	500	1.56
	Upper Mainstem JD	Intermediate	1000	1.35
Umatilla / Walla Walla Rivers	Umatilla R.	Large	1500	1.26
	Walla Walla R.	Intermediate	1000	1.35
	Touchet R.	Intermediate	1000	1.35
	Willow Crk. (Extirp.)	Intermediate	1000	1.35
Yakima River Group	Satus Cr.	Intermediate[2]	1000	1.35
	Toppenish Cr.	Basic	500	1.56
	Naches R.	Large	1500	1.26
	Upper Yakima	Large	1500	1.26

Recovery Goals and Delisting Criteria

The recovery goals that are incorporated into a locally developed recovery plan may include delisting, reclassification (e.g., from endangered to threatened), and/or other "broad sense" goals that may go beyond the requirements for delisting to address, for example, other legislative mandates or social, economic, or ecological values. NMFS' delisting criteria may include both technical and policy considerations. Delisting criteria must meet the ESA requirements, while recovery may be defined more broadly. A third "term of art" used in this recovery plan is recovery "scenarios" (Section 3.3). Recovery scenarios are combinations of viability status for individual populations within the DPS that will meet the ICTRT criteria for overall DPS viability.

Recovery criteria are of two kinds: the biological viability criteria, which deal with the VPS parameters at the population, MPG, and DPS levels, and the "threats" criteria, which relate to the five listing factors detailed in the ESA (see Sections 1.3 and 3.4 of this Plan). The threats criteria define the conditions under which the listing factors, or threats, can be considered to be

[1] This population is treated as Intermediate in size with respect to abundance and productivity criteria because of constraints on currently accessible habitat (i.e. Pelton Dam).
[2] For the historical population analysis, the ICTRT included the mainstem Yakima habitat below the confluence of Satus Creek in the Satus Creek population, making it Intermediate in size. However, if the mainstem component is lumped instead with mainstem Yakima River habitat upstream of Satus, the Satus Creek population would drop to Basic size. The Yakima Steelhead Recovery Plan discusses this question in more detail.

addressed or mitigated. Together these make up the "objective, measurable criteria" required under section 4(f)(1)(B) for the delisting decision.

The delisting criteria are based on the best available scientific information and incorporate the most current understanding of the DPS and the threats it faces. As this recovery plan is implemented, additional information will become available that can increase certainty about whether the threats have been abated, whether improvements in population and DPS status have occurred, and whether linkages between threats and changes in salmon status are understood. These criteria will be assessed through an adaptive management program under development for the Plan, and NMFS will thoroughly review the criteria during its 5- and 10-year status reviews of the DPS.

Biological Viability Criteria

In 2007, the ICTRT completed its Technical Review Draft of *Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs* (ICTRT 2007a). Biological viability criteria describe DPS characteristics associated with a low risk of extinction for the foreseeable future. These criteria are expressed in terms of the VSP parameters of abundance, productivity, spatial distribution, and diversity, according to guidelines developed by NOAA's Northwest Fisheries Science Center and published as a NOAA Technical Memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000; ICTRT 2007a). The ICTRT calculated varying levels of risk of extinction and related the risk levels to their criteria.

DPS Viability

Since MPGs are geographically and genetically cohesive groups of populations, they are critical components of ESU or DPS spatial structure and diversity. Having all MPGs within a DPS at low risk provides the greatest probability of persistence for the DPS.

DPS Viability Criterion (ICTRT 2007a)
All extant MPGs and any extirpated MPGs critical for proper functioning of the ESU/DPS[3] should be at low risk.

MPG Viability

MPG viability depends on the number, spatial arrangement, and diversity associated with its component populations.

[3] The Middle Columbia steelhead DPS has four extant and no extirpated MPGs. The three extirpated populations are addressed as part of the MPG-level criteria.

MPG-Level Viability Criteria
(ICTRT 2007a)

The following five criteria should be met for an MPG to be regarded as at low risk (viable):

1. At least one-half of the populations historically within the MPG (with a minimum of two populations) should meet viability standards.
2. At least one population should be classified as "Highly Viable."
3. Viable populations within an MPG should include some populations classified (based on historical intrinsic potential) as "Very Large," "Large," or "Intermediate," generally reflecting the proportions historically present within the MPG. In particular, Very Large and Large populations should be at or above their composite historical fraction within each MPG.
4. All major life history strategies (e.g. spring and summer-run timing) that were present historically within the MPG should be represented in populations meeting viability requirements.
5. Remaining MPG populations should be maintained with sufficient abundance, productivity, spatial structure, and diversity to provide for ecological functions and to preserve options for ESU/DPS recovery.

The DPS criterion requiring viable populations in each of the extant MPGs would result in sustainable production across a substantial range of environmental conditions. The presence of viable populations across MPGs would preserve a high level of diversity within the DPS, thereby promoting long-term evolutionary potential for adaptation to changing conditions. The presence of multiple, relatively nearby, viable and maintained populations acts as protection against long-term impacts of localized catastrophic loss by serving as a source of re-colonization (ICTRT 2007a).

Population Viability

To be viable, populations should meet criteria for all four VSP parameters (abundance, productivity, spatial structure, and diversity).

Abundance and productivity

The ICTRT defined abundance and productivity criteria for Middle Columbia steelhead populations (ICTRT 2005 and 2007) based on analyses of the intrinsic potential of the historically available habitat, the locations and sizes of major and minor spawning areas, and, within these areas, the abundance and productivity relationships that would result in a probability of low risk of extinction within 100 years (see Table ES-1 above). The abundance "thresholds" shown in the table represent the number of spawners needed for a population of the given size category to achieve the 5 percent (low) risk level at a given productivity.

Spatial structure and diversity

The spatial structure and diversity criteria are specific to each population, and are based on historical spatial distribution and diversity, to the extent these can be known or inferred. The

ICTRT cautions that there is a good deal of uncertainty in assessing the status of spatial structure and diversity in a population (ICTRT 2007a; McElhany et al. 2000).

Recovery Scenarios

The risk levels of the populations within the DPS collectively determine MPG viability and, in turn, the likely persistence of the DPS. The ICTRT recommended that all MPGs in a DPS should be viable; however, it may not be necessary for all of the populations to attain the lowest risk level. There may be more than one way for a DPS to meet the viability criteria.

The ICTRT, in a January 8, 2007 technical memorandum (ICTRT 2007a), offered a detailed discussion of possible recovery scenarios for each MPG. They cautioned against closing off the options for any population prematurely, however, because of the many uncertainties in predicting the biological response to recovery actions. The ICTRT concluded that "a low risk strategy will target more populations than the minimum for viability" (ICTRT 2007a).

The management unit plans include locally determined recovery goals as well as viability criteria for the individual steelhead populations and MPGs in each management unit. Most of the plans also provide targets or objectives to measure progress within specified time frames, e.g. 10 to 50 years.

Threats Criteria

At the time of a delisting decision for the Middle Columbia steelhead, NMFS will examine whether the section 4(a)(1) listing factors have been addressed. To assist in this examination, NMFS will use the listing factors (or threats) criteria described in Section 4.3 of this plan, in addition to evaluation of biological recovery criteria and other relevant data and policy considerations. It is possible that currently perceived threats will become insignificant in the future because of changes in the natural environment or changes in the way threats affect the entire life cycle of salmon. Consequently, NMFS expects that the relative priority of threats will change over time and that new threats may be identified. During the status reviews, NMFS will evaluate and review the listing factor criteria as they apply at that time. NMFS expects that if the proposed actions described in the Plan are implemented, they will make substantial progress toward meeting the listing factor (threats) criteria for the Middle Columbia steelhead.

Current Status Assessment

The status of a salmonid ESU or DPS is expressed in terms of likelihood of persistence over 100 years, or in terms of risk of extinction within 100 years. The ICTRT defines viability at two levels: less than 5 percent risk of extinction within 100 years (viable) and less than 1 percent risk of extinction within 100 years (highly viable). A third category, "maintained," represents a less than 25 percent risk. The risk level of the DPS is built up from the aggregate risk levels of the populations and MPGs. All four VSP parameters must be taken into account to determine the risk level.

Table ES-2 summarizes current status of the Middle Columbia steelhead populations, showing 10-year geometric mean abundance by population, estimated productivity, and the minimum abundance threshold needed for long-term viability. The table also includes the 10-year

geometric mean proportion of hatchery spawners for the populations where data are available, and the risk ratings of high, moderate, low, and very low, for abundance and productivity combined, and spatial structure and diversity combined. Figure ES-5 is a matrix combining all four parameters to illustrate the overall current risk rating of each population.

Current Population Status

According to the ICTRT viability criteria, the majority of natural Middle Columbia steelhead populations are rated at moderate risk for all four VSP parameters – abundance, productivity, spatial structure, and diversity (Table ES-2 and Figure ES-5). This DPS includes one highly viable population (North Fork John Day), two viable (Fifteenmile Creek and Deschutes River Eastside), and three at high risk of extinction within 100 years (Deschutes Westside, Upper Yakima Mainstem, and Naches River).

MPG Status

The viability ratings of the component populations of each Middle Columbia steelhead MPG are shown in Figure ES-5. None of the MPGs as a whole reaches low risk status according to the ICTRT's MPG-level criteria.

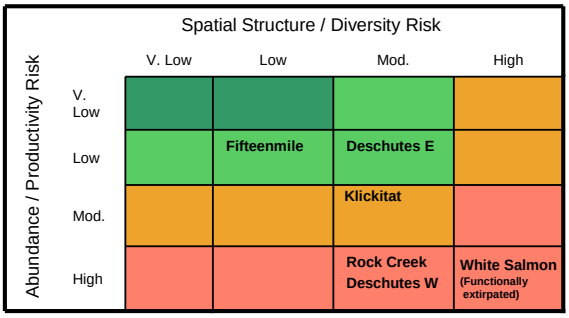
DPS Status

The ICTRT's DPS-level viability criterion is that all extant MPGs and any extirpated MPGs critical for proper functioning of the DPS should be at low risk (ICTRT 2007). Thus, the Middle Columbia steelhead DPS does not currently meet viability criteria based on the determination that the four component MPGs are not at low risk.

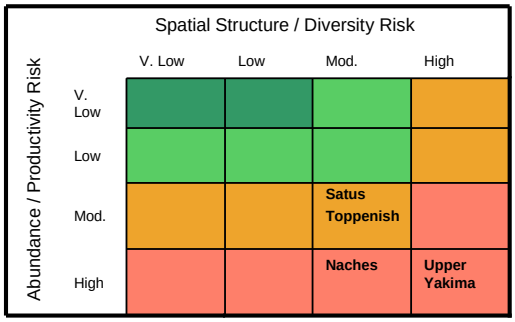
Table ES-2. Middle Columbia River steelhead DPS populations: summary of abundance, productivity, risk ratings, and minimum abundance thresholds (Source: ICTRT 2007c and 2008). (Numbers subject to periodic updates as additional information becomes available.)

Population	*Abundance Threshold*[4]	*Size Category*	*Run Timing*	*10-year Geomean abundance*	*Abundance Range*	*10-yr Hatchery Fraction*[5]	*Produc-tivity*[6]	*Productivity Standard Error*	*A&P Risk*[7] *Rating*	*SSD Risk Rating*
Eastern Cascades MPG										
Deschutes (westside)	1000[8]	Large (Inter)	Summer	456	108-1283	0.26	1.05	0.15	H	M
Deschutes (eastside)	1000	Intermed.	Summer	1599	299-8274	0.39	1.89	0.27	L	M
Klickitat River	1000	Intermed.	Wtr & Smr						M	M
Fifteenmile Creek	500	Basic	Winter	703	231-1922	0	1.82	0.20	L	L
Rock Creek	500	Basic	Summer	Insufficient Data					H	M
White Salmon	500	Basic		Functionally extirpated					N/A	N/A
Crooked River	2250	Very Large	Summer	Extirpated						
Yakima River MPG										
Upper Yakima River	1500	Large	Summer	85	34-283	0.02	1.12	0.22	H	H
Naches River	1500	Large	Summer	472	142-1454	0.06	1.12	0.22	H	M
Toppenish River	500	Basic	Summer	322	44-1252	0.06	1.60	0.30	M	M
Satus Creek (trib only)	1000	Intermed.	Summer	379	138-1000	0.06	1.73	0.14	M	M
John Day Basin MPG										
Lower Mainstem John Day	2250	Very Large	Summer	1800	563-6257	0.1	2.99	0.24	M	M
North Fork John Day	1500	Large	Summer	1740	369-10,235	0.08	2.41	0.22	VL	L
Upper Mainstem John Day	1000	Intermed.	Summer	524	185-5169	0.08	2.14	0.33	M	M
Middle Fork John Day	1000	Intermed.	Summer	756	195-3538	0.08	2.45	0.16	M	M
South Fork John Day	500	Basic	Summer	259	76-2729	0.08	2.06	0.27	M	M
Umatilla/Walla Walla MPG										
Umatilla River	1500	Large	Summer	1472	592-3542	0.36	1.50	0.15	M	M
Walla Walla Mainstem	1000	Intermed.	Summer	650	270-1746	0.02	1.34	0.12	M	M
Touchet River	1000	Intermed.	Summer	Insufficient Data					H	M
Willow Creek	1000	Intermed.	Summer	Extirpated					N/A	N/A

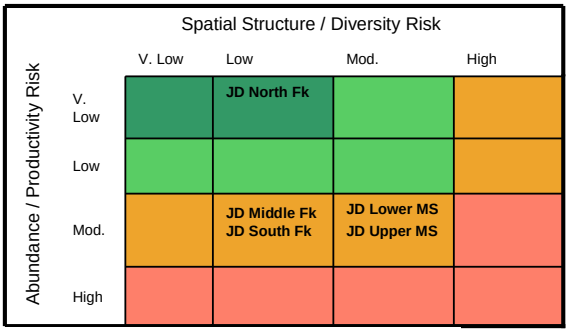
[4] Abundance threshold for viability based on habitat intrinsic potential
[5] Average proportion of hatchery spawners over most recent 10 years in the data series.
[6] Geomean return per spawner calculated over most recent 20 years in data series.
[7] H = high risk, M= moderate risk, L = low risk, VL = very low risk
[8] The Deschutes Westside steelhead population is classified as Large in terms of spatial structure, but its abundance threshold may be considered 1000 or 1500 because of "currently accessible area" considerations. See Carmichael, Richard W., Draft Recovery Plan for Oregon's Middle Columbia River Steelhead: Progress Report. January 17, 2006



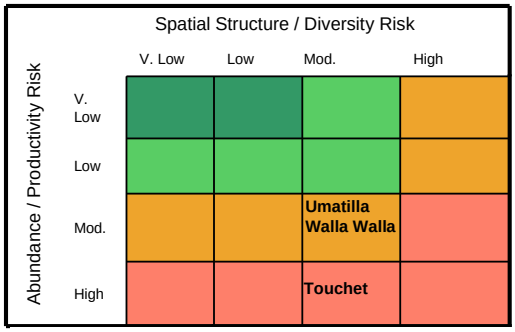
Cascades Eastern Slopes Tributaries Major Population Group.



Yakima River Major Population Group.



John Day Basin Major Population Group.



Umatilla/Walla Walla Major Population Group.

Figure ES-5. Viability Ratings for Middle Columbia Steelhead Populations by MPG (developed by NMFS based on ICTRT 2008)

Gap Analysis

The ICTRT assessed the difference between a listed species' or population's current status for abundance and productivity and the viability criteria. This difference is called the "gap." The gap, as used in this plan, is a measure, although it is inevitably imprecise, of the improvement in survival needed to meet viability criteria. As such, it is also an indicator of the level of effort needed to achieve recovery.

The ICTRT calculated the gap for each extant Middle Columbia steelhead population based on current abundance and productivity for the listed salmon and steelhead in the Interior Columbia Basin (ICTRT 2007c). They estimated the minimal survival rate changes needed for Middle Columbia steelhead populations to meet the abundance and productivity viability criteria for a 5 percent risk of extinction in a 100-year time frame.

In addition, the ICTRT (2007) estimated gaps under three different early-ocean survival scenarios; historical ocean conditions (ocean conditions that fish experienced over the past 60 years), pessimistic ocean conditions (ocean conditions experienced by the 1975-1997 brood years), and recent ocean conditions (ocean conditions experienced by fish during the 20-year assessment period). The ICTRT also estimated gaps assuming three different hydropower scenarios. However, only the base hydro condition, which assumed

that survival rates from the most recent 20 years would continue into the future, is reported here. (See NMFS 2008a for details on survival through the FCRPS under proposed improvements.)

A positive number, e.g. 21 percent gap for Eastern Cascades MPG, means the populations's overall survival needs to increase 21 percent over current conditions to achieve viability criteria. A zero or negative number would mean there is no gap – the population currently meets viability criteria.

The analysis showed that none of the MPGs would be able to achieve a 5 percent or less risk of extinction over 100 years without recovery actions (Table ES-3). The Yakima Basin MPG shows the largest gap (77 percent) and also contains two historically large populations now at high risk of extinction, the Upper Yakima River and Naches River populations.

Table ES-3. Median survival gap for the major population groups of the Middle Columbia Steelhead DPS (assuming recent ocean and base hydrosystem conditions and 5 percent risk)

Eastern Cascades MPG	21 percent
John Day MPG	9 percent
Umatilla/Walla Walla MPG Sufficient data for only two of the three populations: Umatilla Walla Walla	 9 percent 34 percent
Yakima	77 percent

Limiting Factors and Threats

The reasons for a species' decline are generally described in terms of limiting factors and threats. NMFS defines limiting factors as the biological and physical conditions that limit a species' viability – e.g., high water temperature – and defines threats as those human activities or natural processes that cause the limiting factors. For example, removing the vegetation along the banks of a stream can cause higher water temperatures, because the stream is no longer shaded. The threats contributing to the limiting factors and causes for a species' decline are often described in terms of the "four Hs" – habitat (usually relating to the effects of land use and tributary water use), hydropower, harvest, and hatcheries. While the term "threats" carries a negative connotation, it does not mean that activities identified as threats are inherently undesirable. They are typically legitimate and necessary human activities that may at times have unintended negative consequences on fish populations—and that can also be managed in a manner that minimizes or eliminates the negative impacts.

Designing effective recovery strategies and actions requires understanding limiting factors and threats across the species' entire life cycle and across the four Hs. This plan describes limiting factors and threats for the Middle Columbia steelhead DPS as a whole at a general level, and notes the most salient specific conditions that affect individual populations and limit the viability of specific MPGs. More detail is available in the individual management unit plans (Appendices A through F).

Limiting Factors and Threats for the DPS

At a general level, based on information from the ICTRT and the four management unit plans, the major factors limiting the viability of Middle Columbia steelhead populations are *degraded tributary habitat*, *impaired fish passage in the mainstem Columbia River and tributaries, hatchery-related effects, and predation/competition/disease.* Two other factors, degradation of estuarine and nearshore marine habitat and harvest-related effects, pose some risk to steelhead viability for the entire DPS, but less than the other factors. Climate change represents a potentially significant threat to recovery of Middle Columbia steelhead populations (see ISAB 2007 and Section 6.3.8 of this plan).

Limiting Factors and Threats for the MPGs

The MPG-level summaries of limiting factors are based on population-level summaries compiled from the relevant management unit plans.

Cascade Eastern Slope Tributaries MPG

The following are major limiting factors for the Cascades Eastern Slope Tributaries MPG (see also the Oregon Steelhead Recovery Plan [Appendix A] and the Klickitat Recovery Plan [Appendix B]):

Tributary habitat. Degraded tributary habitat is a limiting factor to a greater or lesser degree throughout the area, including degraded riparian areas, reduced recruitment of large woody debris (LWD), altered sediment routing, low or altered stream flows, degraded water quality (especially high water temperatures), impaired floodplain connectivity/function, altered channel structure/complexity, and impaired fish passage.

Mainstem passage. Mainstem Columbia River hydro system effects are least for the Fifteenmile Creek and Klickitat River populations, which pass only one mainstem dam. The Deschutes River populations pass two mainstem dams, and the Rock Creek population passes three.

Hatchery related effects. Influence from hatchery fish could be a significant factor for this MPG because of out-of-subbasin straying onto natural spawning grounds in the Deschutes River and also because of potential effects of hatchery releases on naturally produced steelhead in the Klickitat River. The Oregon Mid-C Expert Panel considered out-of-subbasin (and out-of-DPS) hatchery strays a primary threat to genetic traits and productivity of naturally produced Deschutes river steelhead populations. Out-of-DPS hatchery strays comprised an estimated average of 29 percent of the Eastside population and 15.2 percent of the Westside population since 1990 (ICTRT 2008). This high fraction resulted in moderate risk ratings for spawner composition for both populations.

Blocked migration to historically accessible habitat. Historically, summer steelhead had free access to most of the Deschutes watershed. Currently the Pelton-Round Butte Hydroelectric Project (Project), constructed at river mile (RM) 100 on the mainstem Deschutes River, creates the primary barrier to anadromous fish attempting to reach spawning and rearing areas in the upper basin. Plans are underway to reinitiate fish passage facilities at the Pelton-Round Butte complex (details in Oregon Steelhead Recovery Plan) and reintroduce steelhead to the upper basin.

Predation/competition/disease. This refers to predation, competition, and disease issues in mainstem and estuary that affect all of the Middle Columbia steelhead populations (see Section 6.3.5 of this plan). In addition, the Oregon Steelhead Recovery Plan hypothesizes that the abundance of the Deschutes River Westside population may be limited by competition with a large resident population of rainbow trout.

John Day River MPG

The following are major limiting factors for the John Day River MPG (see also the Oregon Steelhead Recovery Plan [Appendix A]):

Mainstem passage. These populations must pass three dams; thus, limiting factors include direct mortality of pre-smolts and smolts at John Day, The Dalles, and Bonneville dams; delayed upstream migration of returning adults; false attraction of returning adults over McNary Dam; and cumulative impact of hydropower system on mainstem and estuary habitat.

Hatchery related effects. Hatchery fish straying into natural spawning areas pose risks to genetic traits and productivity of naturally produced steelhead. Concern over competition for resources with wild fish and potential hybridization with natural-origin fish resulted in termination of all hatchery stocking of *O. mykiss* in the John Day River basin in 1997. Most hatchery stray recoveries occur in the lower mainstem John Day River below the North Fork; however, strays have been observed in all populations.

Tributary habitat. For all five John Day populations, degraded floodplain and degraded channel structure (key habitat quantity and habitat diversity), altered sediment routing, water quality (temperature), and altered hydrology are limiting factors. For the Lower and Upper Mainstem and South Fork populations, passage obstructions in some of the smaller tributaries are also significant.

Predation/competition/disease. This refers to predation, competition, and disease issues in mainstem and estuary that affect all of the Middle Columbia steelhead populations.

Umatilla/Walla Walla MPG

The following are the major limiting factors for the Umatilla/Walla Walla MPG (see also the Oregon Steelhead Recovery Plan [Appendix A] and the Southeast Washington Recovery Plan [Appendix F]):

Mainstem passage. The Walla Walla and Touchet populations must pass four major dams; the Umatilla population must pass three.

Tributary habitat. For all three populations, water quality (temperature), sediment routing dysfunction, blocked and impaired fish passage, degraded floodplain and channel structure (key habitat quantity and habitat diversity) and hydrologic alterations are limiting factors.

Hatchery related effects. The hatchery program on the Umatilla River uses endemic (native) stock and is not currently considered a threat to wild steelhead; however, out-of-DPS strays pose a risk to spawner composition. Non-endemic hatchery fish are considered a potential threat to the Walla Walla wild steelhead population. Currently, data are insufficient to determine whether hatchery effects are a problem for the Touchet River population. An endemic stock program is under development for the Walla Walla and Touchet.

Predation/competition/disease. This refers to predation, competition, and disease issues in mainstem and estuary that affect all of the Middle Columbia steelhead populations.

Yakima Basin MPG

The following are primary limiting factors for the Yakima MPG (see also the Yakima Steelhead Recovery Plan [Appendix E]):

Mainstem passage. As the farthest upstream populations in the DPS, the Yakima populations must pass four dams and undergo higher exposure to altered habitat and avian and piscine predators in the mainstem Columbia.

Tributary habitat. Fish habitat in the Yakima subbasin is substantially influenced by the development of irrigation systems. Limiting factors include altered hydrology (low summer flow because of withdrawals in tributaries and the lower Yakima, scouring peak flows because of degraded watershed conditions, high summer delivery flows in mainstem Yakima and Naches rivers, reduced winter and spring flows due to irrigation storage, delivery, and withdrawals); degraded riparian area and LWD recruitment; blocked and impaired fish passage (primarily due to storage and diversion dams, as well as entrainment in unscreened diversions); altered sediment routing; degraded water quality; loss of historical habitat because of blocked or impaired fish passage; degraded floodplain connectivity and function (loss of off-channel habitat, side channels and connected hyporheic zone); degraded channel structure and complexity; reduced outmigrant survival in the mainstem Yakima.

Hatchery related effects. The Yakima populations have the lowest rates of hatchery strays in the DPS, and hatchery effects are not considered a significant limiting factor.

Predation/competition/disease. Of the Middle Columbia steelhead populations, the Yakima basin populations have the longest migration through the mainstem Columbia River. They may therefore be more vulnerable to some factors such as avian and piscivorous fish predation. For example, Yakima steelhead, but not the others, are consumed by Caspian tern and double-crested cormorants nesting on islands at the mouth of the Snake River.

DPS Recovery Strategy

NMFS' overall goal for DPS viability, as formulated by the ICTRT and described in Chapter 3 of this plan, is to have all four extant MPGs at viable (low risk) status, with representation of all the major life history strategies present historically, and with the

abundance, productivity, spatial structure and diversity attributes required for long-term persistence.

The ICTRT's current status assessment for the Middle Columbia steelhead DPS and the gaps analysis show that for this DPS, the outlook is optimistic. One population, North Fork John Day, is currently at very low risk or "highly viable." Two populations are currently viable (Deschutes Eastside, Fifteenmile); eleven are at moderate risk, with good prospects for improving. However, the three large populations at high risk (Deschutes Westside, Naches, and Upper Yakima), are important to DPS viability; as a minimum, Deschutes Westside and one of the two large Yakima populations should also reach viable status. These present significant, though not insuperable, challenges. Because of the steelhead's complex life cycle and the many changes that have taken place in its environment, the factors limiting its survival must be addressed in concert, and in an integrated way. The work needs to occur at a regional level, in terms of commitment to actions and funding, and at the local level, population by population.

NMFS' 2006 listing decision called upon Federal, state, and tribal entities to do their best to manage land, hydropower, hatchery, and harvest activities in a manner that would support steelhead recovery. This plan reaffirms those recommendations and adds to them with the contributions of science and consensus building accomplished in the management unit plans.

The recovery strategy for the Middle Columbia steelhead DPS is made up of the following elements:

- Address the limiting factors for each major population group and population, following the recommendations in the 2006 listing decision, making use of the strategies and actions developed in the management unit plans, in concert with the strategies and actions provided in the NMFS 2008 FCRPS Biological Opinion, NMFS Estuary Module, Hatchery and Genetic Management Plans (HGMPs) and *Artificial Production for Pacific Salmon* (Appendix C of Supplemental Comprehensive Analysis, NMFS 2008), fishery management planning through *U.S. v. Oregon* for mainstem fisheries and Fisheries Management Evaluation Plans for tributary fisheries.

- Address and coordinate DPS-wide and basin-wide issues through the Middle Columbia Forum (a bi-state, tri-tribe group convened by NMFS to provide input on the development and implementation of the DPS recovery plan).

- Coordinate research, monitoring, and evaluation throughout the range of the DPS

- Conduct periodic comprehensive reviews of new information generated through the research, monitoring, and evaluation program. Adapt the strategies and actions as appropriate to achieve the recovery plan goals.

NMFS believes that if this strategy is implemented and the biological response is as expected, the Middle Columbia steelhead DPS is likely to achieve viable status within 25 to 50 years.

Recovery Strategies for the Four Major Population Groups

These summaries of recovery strategies for the four major population groups are drawn from the management unit plans and the ICTRT's status assessment (ICTRT 2008).

Cascades Eastern Slope Tributaries MPG

Population	ICTRT Risk Status
Fifteenmile Creek (Oregon)	Viable
Deschutes Eastside (Oregon)	Viable
Klickitat (Washington)	(provisional) Moderate risk – insufficient data, hatchery influence
Rock Creek (Washington)	(provisional) High risk – insufficient data
Deschutes Westside (Oregon)	High risk
White Salmon (Washington)	Functionally extirpated
Crooked River (Oregon)	Extirpated

Primary limiting factors and threats (Section 6.4.1):

- Degraded tributary habitat
- Mainstem passage
- Hatchery related effects
- Blocked migration to historically accessible habitat
- Predation, competition, disease – in mainstem and estuary; possibly also in Deschutes Westside as competition with resident rainbow trout.

Gap: The median survival gap (assuming recent ocean and base hydrosystem conditions and 5 percent risk) for the Eastern Cascades MPG is 0.21 (meaning that a 21 percent increase in average life-cycle survival is required to achieve 5 percent risk in a 100-year time period). The gap ranges from –0.34 (Deschutes Eastside) (no gap) to 0.78 (Deschutes Westside) (needs 78 percent improvement). There was not enough information to estimate gaps for the Klickitat or Rock Creek populations.

Recovery Scenario: For the Eastern Cascades Slope Tributaries MPG to be considered viable based on the currently extant populations, the Klickitat, Fifteenmile, and both the Deschutes Eastwide and Westside populations should reach viable status, with one highly viable. The Rock Creek population should reach "maintained" status (25 percent or less risk level). MPG viability could be further bolstered if reintroduction of steelhead into the Crooked River succeeds and if the White Salmon population is successfully reintroduced to its historical habitat.

Key actions proposed (Section 7.3.1):

- Protect, improve, and increase freshwater habitat for steelhead production. Improvements to freshwater habitat should be targeted to address specific limiting

factors in specific areas as described in the Oregon Steelhead Recovery Plan and the Washington Gorge plans.
- Reduce straying of out-of-DPS hatchery fish onto natural spawning grounds within the Deschutes subbasin.
- Restore historical passage to the upper Deschutes subbasin including the Westside tributaries and Crooked River above Pelton Round Butte dam complex and the White Salmon River above Condit Dam.
- Improve survival in mainstem and estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008) (as summarized in the Hydro Module [NMFS 2006 and in preparation).
- Improve hatchery management to minimize impacts from hatchery releases on naturally produced steelhead within the Deschutes West and East and Klickitat subbbasins
- Fill data gaps for better assessment of Klickitat and Rock Creek steelhead populations.
- Coordinate between scientists, planners, and implementers of recovery actions on both sides of the Columbia River for sequencing of recovery actions and monitoring for adaptive management.

John Day River MPG

Population	**ICTRT Risk Status**
North Fork John Day	Highly viable
Upper Mainstem John Day	Moderate risk
Lower Mainstem John Day	Moderate risk
Middle Fork John Day	Moderate risk
South Fork John Day	Moderate risk

Main limiting factors and threats (Section 6.4.2):
- Degraded tributary habitat
- Mainstem passage
- Hatchery related effects
- Predation/competition/disease in mainstem and estuary.

Gap: The median survival gap for the John Day MPG is 0.09, ranging from –0.49 (North Fork) (no gap) to 0.34 (South Fork) (needs 34 percent improvement in average survival over the life cycle).

Recovery Scenario: For the John Day River MPG to reach viable status, the Lower Mainstem John Day River, North Fork John Day River, and either the Middle Fork John Day River or Upper Mainstem John Day River populations should achieve viable status, with one highly viable.

Key Actions proposed (7.3.2):
- Protect and improve freshwater habitat conditions and connectivity for steelhead production. Improvements to freshwater habitat should be targeted to address

specific factors in specific areas as described in the Oregon Steelhead Recovery Plan.
- Improve hatchery management to reduce straying from out-of-DPS hatchery fish onto natural spawning grounds within the John Day subbasin.
- Improve survival in mainstem and estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008)

Yakima River MPG

Population	**ICTRT Risk Status**
Upper Yakima River	High Risk
Naches River	High Risk
Satus Creek	Moderate Risk
Toppenish Creek	Moderate Risk

Main limiting factors and threats (Section 6.4.3):
- Tributary habitat: Influence of major irrigation system development. Altered hydrology; degraded habitat; loss of habitat; impaired fish passage; reduced outmigrant survival in Yakima mainstem.
- Mainstem passage (four dams)

Status: The Yakima MPG is currently rated at High Risk. The two largest populations in the drainage (Naches and Upper Yakima) are rated at High Risk; the Satus Creek and Toppenish Creek populations are rated as Maintained.

Gap: The median survival gap (assuming recent ocean and base hydrosystem conditions) for the Yakima MPG is 0.77 (needs 77 percent improvement in average survival over the life cycle), ranging from 0.22 (Satus—tributary only) to 1.15 (Upper Yakima). This is the highest median survival gap of the four MPGs in the Middle Columbia steelhead DPS.

Recovery Scenario: For the Yakima River MPG to achieve viable status, two populations should be rated as viable, including at least one of the two classified as Large - the Naches River and the Upper Yakima River. The remaining two populations should, at a minimum, meet the Maintained criteria.

Key actions proposed (Section 7.3.3):
- Protect and enhance habitat in key tributary watersheds in the Yakima Basin.
- Restore passage to blocked areas in the Naches and Upper Yakima population areas.
- Alter irrigation delivery and storage operations in the Yakima Basin to improve flow conditions for Middle Columbia steelhead and use managed high flows to maintain floodplain habitat.
- Improve channel and floodplain function and reduce predation through the mainstem Yakima and Naches Rivers.

- Improve survival in the mainstem Columbia and its estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008)

Umatilla/Walla Walla MPG

Population	ICTRT Risk Status
Umatilla River	Moderate Risk
Walla Walla River	Moderate Risk
Touchet River	High Risk (provisional because of insufficient data)

Main limiting factors and threats (Section 6.4.3):

- Mainstem passage (Touchet and Walla Walla populations pass four major dams: the Umatilla population must pass three)
- Tributary habitat
- Hatchery related effects
- Predation/competition/disease

Gap: There was sufficient information available to estimate gaps for only two of the three populations within the Umatilla/Walla Walla MPG. Assuming base hydrosystem and recent ocean conditions, the survival gaps for the Umatilla and Walla Walla populations are 0.09 and 0.34, respectively.

Recovery Scenario: For the Umatilla/Walla Walla MPG to be viable, two populations should meet viability criteria, and one should be highly viable. The Umatilla River is the only large population, and therefore needs to be viable. Either the Walla Walla River or Touchet River population also need to be viable.

Key actions proposed (Section 7.3.4):

- Coordinate between planners, scientists and those implementing recovery actions in Washington and Oregon for sequencing, monitoring, and adaptive management
- Protect and improve freshwater habitat conditions and access for steelhead production. Improvements to freshwater habitat should be targeted to address specific factors in specific areas as described in the Southeast Washington Plan and the Oregon Steelhead Recovery Plan.
- Improve hatchery management to reduce straying from out-of-DPS hatchery fish onto natural spawning grounds within the Umatilla/Walla Walla subbasins.
- Improve survival in mainstem and estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008)

DPS-Wide and Basin-Wide Issues

Problems in migratory corridors for juvenile and adult steelhead in tributaries and the mainstem Columbia River should be addressed to improve survival.

Impaired fish passage – mainstem Columbia River
Passage for juvenile steelhead migrating to the ocean and adult steelhead returning to their natal streams is limited primarily by the four Federal dams on the Lower Columbia River mainstem – Bonneville, John Day, The Dalles, and McNary – which are part of the Federal Columbia River Power System (FCRPS). NMFS recently issued a new biological opinion on the effects of FCRPS operations on salmonids, including Middle Columbia River steelhead, and on the predicted results of current and planned improvements to the system that are intended to improve fish survival (NMFS 2008). These improvements are expected to increase the in-river survival of Middle Columbia River juvenile steelhead by 0.3 percent, 5.1 percent, 8.2 percent, and 10.2 percent, depending on the number of dams they must pass. The survival of steelhead adults through the four dams is thought to be relatively high at the present time (about 98.5 percent per project from Bonneville to McNary), and is expected to be maintained or improved.

The current plan for operation of the FCRPS through 2018 (NMFS 2008) contains the following actions intended to address the needs for survival and recovery of ESA-listed salmon and steelhead:

- Continue adult fish passage operations that have resulted in improved survival.
- Improve juvenile fish passage: install removable spillway weirs or similar surface bypass devices at John Day and McNary dams, an extended tailrace spill wall at The Dalles Dam, and various modifications at Bonneville Dam. Passage for steelhead smolts at each of the four Lower Columbia River mainstem projects must reach 96 percent survival.
- Continue and enhance spill for juvenile fish passage.
- Continue reservoir operations and river flows to benefit spring migrating juveniles.
- Develop dry water year operations to better protect migrating juveniles.

Dissenting View of State of Oregon Regarding Mainstem Operations

At the time this proposed recovery plan was being finalized, August 2008, it was the position of the State of Oregon that additional or alternative actions should be taken in mainstem operations of the FCRPS for ESA-listed salmon and steelhead. Some additional or alternative actions recommended by Oregon, while considered, were not included in NOAA's FCRPS Biological Opinion. At this time, Oregon is a plaintiff in litigation against various federal agencies, including NOAA, challenging the adequacy of the measures contained in the current FCRPS Biological Opinion. NOAA is not in agreement with Oregon regarding the need for or efficacy of Oregon's additional or alternative actions.

Impaired fish passage – tributaries

Actions to address fish passage in tributaries include:

- Implement locally developed management unit plans to improve fish passage in tributaries.

- Implement recommendations regarding improved passage and flow management by the U.S. Bureau of Reclamation below all its facilities in the Yakima River and the Umatilla River subbasins, provision of fish passage into significant tributaries, and provision of passage over at least two of its storage dams in the Yakima Basin.[9]

- Implement recommendations regarding improvement of fish passage, screening, and flow management in the Walla Walla River subbasin by the U.S. Army Corps of Engineers, and alteration of the flood operating rule for Mill Creek, or alternatively screening the diversion into Bennington Lake.

- Provide passage into the upper Deschutes River above Round Butte/Pelton complex and into the White Salmon River above Condit Dam.

Degraded tributary habitat

Measures to improve tributary habitat are contained in the management unit plans and are summarized above by MPG.

Hatchery-related effects

The hatchery programs in the Middle Columbia are managed under the Mitchell Act and the *U.S. v. Oregon* process, involving the fisheries co-managers and regulated by NMFS. NMFS is working with the funding agencies and hatchery operators to update and complete Hatchery and Genetic Management Plans (HGMPs) for every hatchery program in the Middle Columbia region as a means of organizing hatchery review and reform. The HGMPs are the basis for NMFS' biological opinions on hatchery programs under sections 7 and 10 and the 4(d) rule, which relate to incidental and direct take of listed species. The HGMPs describe each hatchery's operations and the actions taken to support recovery and minimize ecological or genetic impacts, such as straying and other forms of competition with naturally produced fish.

Evaluating the factors that influence interactions between hatchery fish and naturally produced fish under varying freshwater conditions and ocean conditions is an important area of future research as well as ESA consultations and NEPA review. This is dealt with in more detail in Appendix C of the 2008 FCRPS Biological Opinion (NMFS 2008).

[9] The conservation measures in NOAA's 2006 listing decision specifically identify the need for passage at two or more of the storage dams in the Yakima Basin. The Yakima Steelhead Recovery Plan strongly recommends the provision of passage at the storage dams, but notes that the geographic distribution criteria detailed in the plan do provide for combinations of spawning areas that would meet de-listing and short-term recovery thresholds without provision of access above the storage dams (See Appendix E, Section 4.3.7)

The management unit plans propose various actions to reduce deleterious effects of hatcheries on natural production. For example, The Oregon Steelhead Recovery Plan proposes increased marking of Columbia Basin hatchery steelhead with coded-wire tags, and requiring mass marking of all hatchery steelhead releases with, at a minimum, an adipose fin-clip. Regional consensus has not been reached on these strategies, and the Mid-Columbia Forum will continue to pursue agreement on appropriate site-specific strategies. The Klickitat subbasin plan recommends a targeted monitoring program to determine abundance and productivity of natural spawners, determine the proportion of hatchery and wild spawners in the Klickitat subbasin, and determine the adverse effects of Skamania broodstock on the Klickitat population, if any. Further details are available in each management unit plan.

Predation, Competition and Disease
Major predation issues in the mainstem Columbia River are addressed in Section 7.4.4. NMFS supports the recommendations in the Yakima Steelhead Plan for research and monitoring to track trends in predator populations, understand their impacts on steelhead, and develop appropriate management techniques to reduce predation. Disease in salmonids is caused by multiple factors and probably cannot be directly addressed by recovery actions except in specific instances of known causal factors. It is more likely that nearly all of the recommended recovery actions that improve spawning, rearing, and passage conditions for steelhead and increase the survival, abundance, and productivity of naturally produced fish will result in decreasing incidence of disease.

Harvest
Although in general harvest is not considered a major threat for the Middle Columbia steelhead DPS, it is important to ensure that impacts from fisheries do not impede recovery, and to perform monitoring and evaluation to verify impacts and reduce existing uncertainties.

Time Required and Cost Estimates

It is important to consider the unique characteristics and challenges of estimating time and cost for salmon and steelhead recovery, given the complex relationship of these fish to the environment and to human activities on land. NMFS estimates that recovery of the Middle Columbia steelhead DPS, like recovery for most of the ESA-listed Pacific Northwest salmon and steelhead, could take 50 to 100 years, although the optimistic view is that it could be much sooner. The management unit plans (Appendices A through F) contain extensive lists of actions to recover the Middle Columbia steelhead DPS populations. These projects were developed using the most up-to-date assessment of Middle Columbia steelhead recovery needs. The management unit plans focus, for the most part, on actions within the next 5 to 15 years. There are many uncertainties involved in predicting the course of recovery and in estimating total costs. Such uncertainties include biological and ecosystem responses to recovery actions as well as long-term and future funding.

Cost Estimates

Cost estimates for recovery projects were provided by the management unit entities where available information was sufficient to do so, using the methods described in each management unit plan. No cost estimates are provided for (1) baseline actions (programs that are already in existence and would occur regardless of this recovery plan), which are listed as Not Applicable (N/A); or (2) actions that need costs to be developed, need unit costs, and/or need project scale estimates. These are listed as To Be Determined. Cost figures will be updated as improved information becomes available.

The total estimated cost of restoring habitat for the Middle Columbia steelhead DPS is approximately $235 million over the initial 5-year period, and approximately $970 million over 20 to 50 years for all DPS-wide recovery actions for which sufficient information exists upon which to base an estimate (Table ES-4).

Table ES-4 Summary of Cost Estimates for Habitat Projects for Middle Columbia Steelhead DPS

Recovery Plan	First 5 Years ($M)	Project/Program Total ($M)
Oregon	$ 103.5	$ 512.8
Yakima Steelhead[10]	$ 91.9	$ 269.3
SE Washington[11]	$ 25.5	$ 76.4
Klickitat[12],[13]	$ 12.9	$ 103.6
Rock Creek[14]	$ 1.0	$ 1.8
White Salmon Steelhead	N/A	$ 6.5
DPS Totals	**$ 234.8**	**$ 970.4**

This estimate includes expenditures by local, tribal, state, and Federal governments, private business, and individuals in implementing both capital projects and non-capital work. Administrative costs are embedded in the total management unit cost estimates in Table ES-4. Preliminary research, monitoring and evaluation costs have, in some cases,

[10] The Yakima steelhead plan estimates costs for the first 6 years, and includes preliminary RME cost estimate of $300K/year. The 5-year estimate is extrapolated from the 6-year cost data .
[11] The SE Washington plan estimates annual steelhead implementation costs at about $5 million per year. The 5-year estimate is extrapolated by multiplying the annual amount by five.
[12] The Klickitat plan estimates costs for the first 10 years. Five-year estimate extrapolated by dividing the 10-year amount in half.
[13] The Klickitat plan uses a 50-year period to estimate its total project costs.
[14] The Rock Creek plan estimates cost for first 3 years and 10 years. The 5-year estimate is extrapolated from the 3-year value.

been estimated at the management unit level; however, these costs are not included at this time pending completion of research and monitoring plans and further development of each project.

These cost estimates do not include expenses associated with implementing actions within the lower Columbia River, estuary, or Federal Columbia River Power System (FCRPS), first, because of the basin-wide scope and applicability of these actions to all 13 Columbia Basin salmonid species listed as threatened or endangered, and second, because they are considered "baseline actions" that are required through other processes such as section 7 consultations, FERC licensing agreements, and Habitat Conservation Plans, and these costs would occur regardless of the recovery plans. Cost estimates for estuary actions are included in a module that is incorporated into the Plan by reference, and is available on the NMFS Web site: www.nwr.noaa.gov/Salmon Recovery Planning/ESA Recovery Plans/Other Documents.cfm. The estuary recovery costs could be further refined following public comment on the module and on the ESA recovery plan for the three listed lower Columbia River ESUs and one listed lower Columbia River steelhead DPS in 2008 or early 2009. Costs for hatchery actions required through other processes such as consultations, permits, and 4(d) Rule implementation are not part of recovery costs reported here because the programs are already in existence or are undergoing required modifications, and the costs would occur regardless of the recovery plan. There are few estimated costs for recovery actions associated with harvest to report at this time. This is because no actions are currently proposed that go beyond those already being implemented through U.S. v. Oregon and other harvest management forums. In the event that additional harvest actions are implemented through these forums, those costs will be added during the implementation phase of this recovery plan. All cost estimates will be refined and updated over time.

Cost estimates from the draft cost chapters in the individual management plans were developed as consistently as possible, in that they all applied guidance provided by NMFS. However, the approaches vary to some degree given the local and independent nature of the planning groups. Costs developed in the management unit plans were estimated using several basic assumptions (i.e., neither baseline costs nor out-of-basin costs were included in the estimates) and used similar cost calculation methodologies. There are, however, differences in the timeframes for cost estimates, whether administrative costs were included or not, and whether research, monitoring and evaluation costs were calculated. The proposed management unit plans' cost estimates will be refined based on public comment, and final cost estimates will be included in the final DPS recovery plan and management unit plans.

Potential Effects of Proposed Recovery Actions

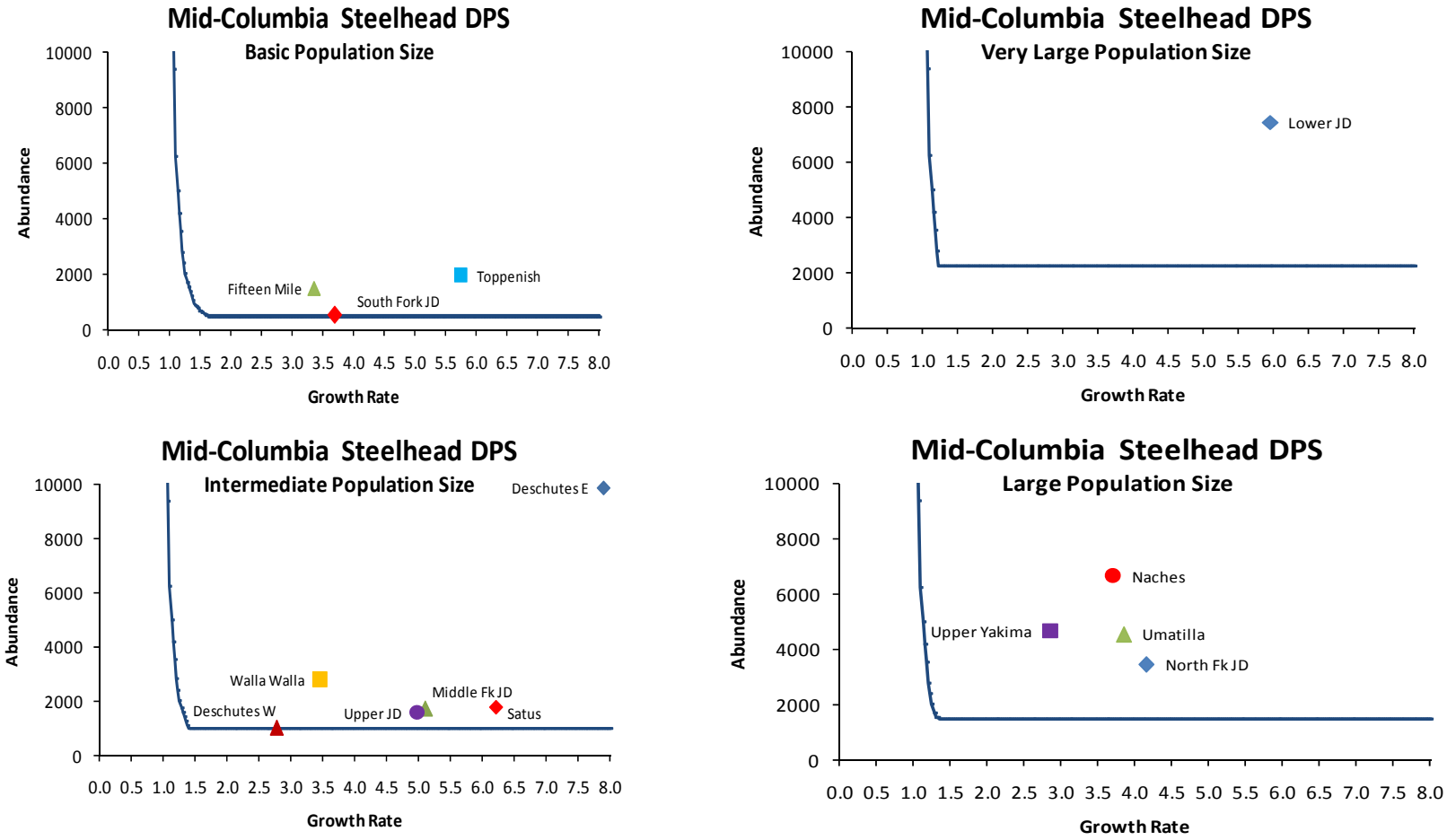
Chapter 9 in this plan presents an analysis of the potential effects of implementing all the proposed recovery actions – in all the "H" sectors – on the abundance and productivity of Middle Columbia River steelhead. This quantitative analysis provides an opportunity to evaluate the efficacy of proposed recovery strategies in light of current knowledge regarding population functioning, including relationships with habitat conditions. Equally important, the quantitative models used in the assessment provide a framework for

productively targeting evaluation efforts as well as for revisiting key assumptions in the future as more information becomes available (e.g., from monitoring responses to initial implementation or from evaluation efforts targeting key uncertainties). Two models were used: Ecosystem Diagnosis and Treatment (EDT) and the All-H-Analyzer (AHA). Methods of analysis are explained in detail in Chapter 9 of this plan.

The analysis indicates, based on the suites of proposed actions in all the sectors, that all Middle Columbia River steelhead populations for which there are adequate data are expected to achieve 95 percent probability of survival (less than 5 percent risk of extinction within 100 years) for abundance/productivity if the most intensive (major) restoration scenarios are implemented and the projected habitat changes are realized after 25 years of implementation. Under minimum restoration scenarios, three populations (Deschutes Westside, Satus, and Upper Yakima) may not achieve less than 5 percent risk for abundance/productivity. However, the Satus population would meet the recovery criteria identified in the Yakima Steelhead Recovery Plan, and even under poor ocean conditions and minimum restoration actions, the abundance and productivity of the other two populations are expected to increase considerably over the baseline.

Figure ES-6 shows the projected (modeled) abundance and productivity of the 14 populations for which there are adequate data (excluding the Rock Creek, Klickitat, and Touchet populations) after 25 years and major restoration actions. The curve represents the abundance and productivity needed to achieve 95 percent probability of survival for the next 100 years.

Figure ES-6. Predicted viability results for Middle Columbia steelhead populations after 25 years of major restoration efforts.



Research, Monitoring, and Evaluation

An important part of the strategy for achieving recovery is the development of a DPS-wide monitoring plan that will support implementation of the recovery plan and long-term adaptive management in response to changes and trends in the data. Two keys to effective implementation are targeting actions to specific areas and monitoring the results of the actions. To achieve these goals, a scientific technical team made up of local scientists, former ICTRT members, and managers will be necessary. The monitoring plan is discussed in more detail in Chapter 10.

Adaptive Management

Adaptive management in salmon recovery planning is a method of decision making in the face of uncertainty. A plan for monitoring, evaluation, and feedback is incorporated into an overall implementation plan so that the results of actions can become feedback on design and implementation of future actions. Adaptive management works by coupling the decision-making process with collection of performance data and its evaluation. Most importantly, it works by offering an explicit process through which alternative strategies to achieve the same ends can be considered.

Within the Middle Columbia Basin, many different organizations, including Federal, state, tribal, local, and private entities, currently conduct programs and actions that could improve Middle Columbia steelhead survival. Development of Middle Columbia regional coordination will be essential for NMFS' future status reviews of the steelhead DPS. Establishing stable funding and staff to produce annual reports is also important.

Management unit planners are developing detailed research, monitoring, evaluation, and adaptive management plans for each management unit based on the principles and concepts laid out in the NMFS draft guidance document, Adaptive Management for Salmon Recovery: Evaluation Framework and Monitoring Guidance (http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/upload/Adaptive_Mngmnt.pdf) The individual RM&E and adaptive management plans will then be combined into a DPS RM&E and adaptive management plan by the Middle-Columbia Science Team. This will ensure that, taken together, the monitoring and evaluation programs for each management unit, combined with monitoring components of the modules incorporated into the plans, address the needs of the entire DPS. The RM&E and adaptive management plans will be used by the Middle Columbia Forum and others to inform and guide projects and programs during implementation.

Setting Priorities

Priorities for recovery actions should be guided by DPS-, MPG-, and population-level recovery criteria and best available scientific information concerning DPS status, the role of the independent populations in meeting DPS and MPG viability, limiting factors and threats, and likelihood of effectiveness of actions. Protection of existing habitat is essential. Issues of funding and local, state, or national support for implementation will also inevitably come into play.

The management unit plans all address these issues in their implementation sections. For recovery actions in the tributaries, priorities will be settled largely at the local level. However, there should be ongoing technical review and support from DPS-level and management unit

science and technical committees. Coordination and communication in "out-of-subbasin" forums will be necessary for actions in the Columbia mainstem, estuary, and/or ocean.

Coordination/Governance

Coordination of actions and information-sharing among fisheries biologists, Tribes, local governments, citizen groups, and state and Federal agencies based in both Oregon and Washington is a key component of recovery for this DPS. Benefits of coordination include:

- Dealing with shared migration areas consistently
- Developing coherent MPG-level strategies where populations are in two states (Cascades Eastern Slope MPG; Umatilla/Walla Walla MPG), or the same population is in both states (Walla Walla population)
- Promoting consistent methods for setting recovery objectives, evaluating strategies, and monitoring progress across populations, MPGs, and the DPS

Middle Columbia Recovery Forum

This coordination is under development. The recent creation of the Middle Columbia Recovery Forum (Mid-C Forum), to be convened regularly by NMFS, is intended to facilitate such collaboration between scientists and recovery planners on both sides of the Columbia River. Figure ES-7 gives an overview of the relationships between these entities. Chapter 11 of this plan describes in more detail the proposed roles and responsibilities.

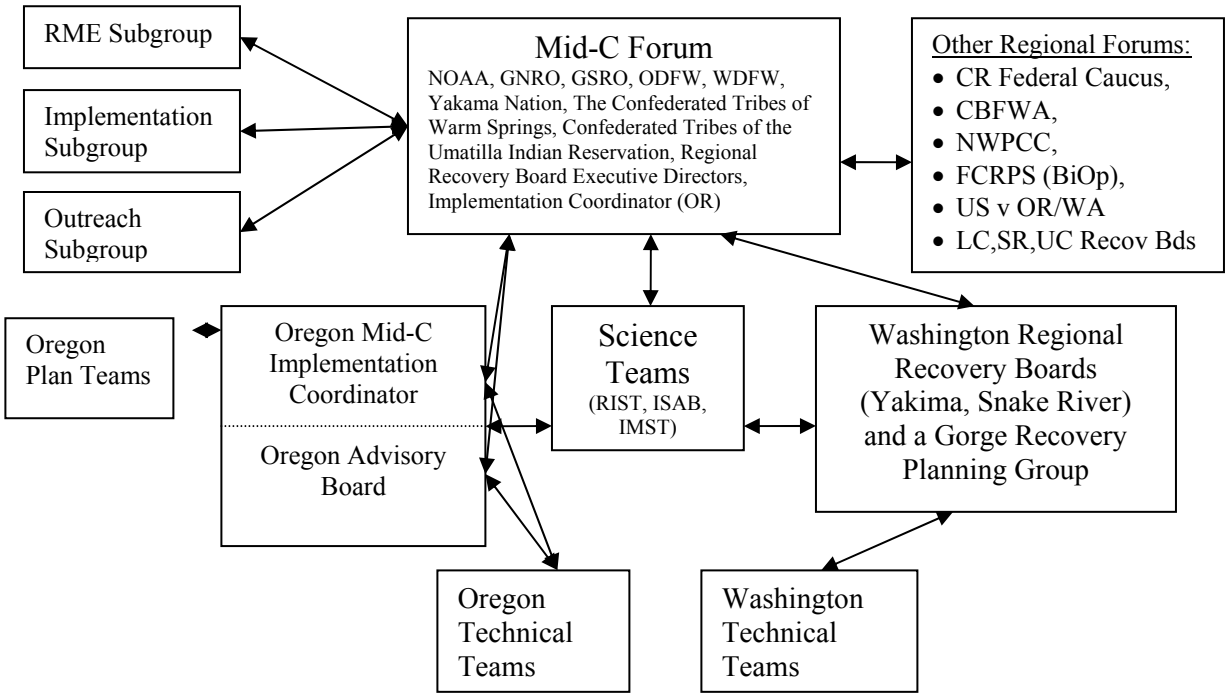


Figure ES-7. Mid-C Recovery Plan Implementation Organizational Structure

Implementation Funding

Funding for project implementation is currently available from a variety of sources, but it will be an ongoing challenge. The role of the Forum is to ensure management unit plan implementers are aware of potential sources of funds and to advocate for the funding and implementation of actions that benefit all populations in the DPS. The Forum will not supersede decisions made by the individual management unit boards but may promote funding of their projects and programs if requested. Sources of implementation funding include:

- Congressional appropriations to Federal agencies and to Pacific Coastal Salmon Recovery Fund (PCSRF) (through states and tribes).
- Salmon Recovery Funding Board (SRFB) (Washington).
- Oregon Watershed Enhancement Board (OWEB) (Oregon).
- State appropriations (State agencies).
- Northwest Power and Conservation Council Fish and Wildlife Program (States and tribes).
- Federal / state grants.
- Non-profit organization programs and grants.

How NMFS Intends to Use the Plan

Although recovery plans are not regulatory and their implementation is voluntary, they are important tools that help to do the following:

- Provide context for regulatory decisions.
- Guide decision making by Federal, state, Tribal, and local jurisdictions.
- Provide criteria for status reporting and delisting decisions.
- Organize, prioritize, and sequence recovery actions.
- Organize research, monitoring, and evaluation efforts.

NMFS will encourage Federal agencies and non-Federal jurisdictions to take recovery plans under serious consideration as they make the following sorts of decisions and allocate their resources:

- Actions carried out to meet Federal ESA section 7(a)(1) obligations
- Actions that are subject to ESA sections 4d, 7(a)(2), or 10
- Hatchery and Genetic Management Plans and permit requests
- Harvest plans and permits
- Selection and prioritization of subbasin planning actions
- Development of research, monitoring, and evaluation programs
- Revision of land use and resource management plans
- Other natural resource decisions at the state, Tribal, and local levels

NMFS will emphasize recovery plan information in ESA section 7 (a)(2) consultations, section 10 permit development, and application of the section 4(d) rule by considering:

- The importance of affected populations to listed species viability
- The importance of the action area to affected populations and species viability
- The relation of the action to recovery strategies and management actions

- The relation of the action to the research, monitoring, and evaluation plan for the affected species

In implementing these programs, recovery plans will be used as a reference and a source of context, expectations, and goals. NMFS staff will encourage the Federal "action agencies" to describe in their biological assessments how their proposed actions will affect specific populations and limiting factors identified in the recovery plans, and to describe any mitigating measures and voluntary recovery activities in the action area.

Middle Columbia River Steelhead ESA Recovery Plan

1. INTRODUCTION

This is a recovery plan (Plan) for the protection and restoration of Middle Columbia River steelhead (*Oncorhynchus mykiss*), which spawn and rear in tributaries to the Columbia River in central and eastern Washington and Oregon (Figure 1-1). The Middle Columbia River steelhead distinct population segment (DPS) was listed as threatened under the Endangered Species Act of 1973 (ESA) on January 5, 2006 (71 FR 834).

NOAA's National Marine Fisheries Service (NMFS) is required, pursuant to Section 4(f) of the Endangered Species Act (ESA) of 1973, to develop recovery plans for marine species listed under the Act. Recovery plans identify actions needed to restore threatened and endangered species to the point that they are again self-sustaining elements of their ecosystems and no longer need the protections of the ESA.

Eighteen of the 33 salmon and steelhead species in the Northwest region are listed as threatened or endangered. The Middle Columbia steelhead is among those with the best prospects of recovery, although it will require considerable political will and investment of long-term effort and funding. Modeling of the potential effects of the actions that are proposed in this plan (see Chapter 9) predicts that the DPS can achieve a "negligible" risk of extinction within a reasonable time frame – e.g. 25 to 50 years – if the actions are taken and if they have the predicted effects on steelhead habitat and survival. Cautious though this statement may be, it is a beacon of hope in the complex realm of salmonid recovery in the Northwest.

A recovery plan serves as a road map for species recovery—it lays out where we need to go and how best to get there. Without a plan to organize, coordinate and prioritize the many possible recovery actions on the part of Federal, state, and tribal agencies, local watershed councils and districts, and private citizens, our efforts may be inefficient or even ineffective. Prompt development and implementation of a recovery plan will help target limited resources effectively. Although recovery plans are guidance, not regulatory documents, the ESA clearly envisions recovery plans as the central organizing tool for guiding each species' recovery process.

Over the course of their life cycle, Middle Columbia River steelhead use habitats across a wide geographic range. They spawn and rear in the upper and middle reaches of freshwater tributaries, then migrate as juveniles through the lower tributary reaches and the mainstem Columbia River to the estuary and ocean. After one to five years in the ocean, the adults migrate upstream to their natal streams. The long-term biological success of steelhead is based on their ability to make use of these diverse habitats. Their resilience in the face of change depends on maintaining genetic, phenotypic, and behavioral diversity over a wide geographic area.

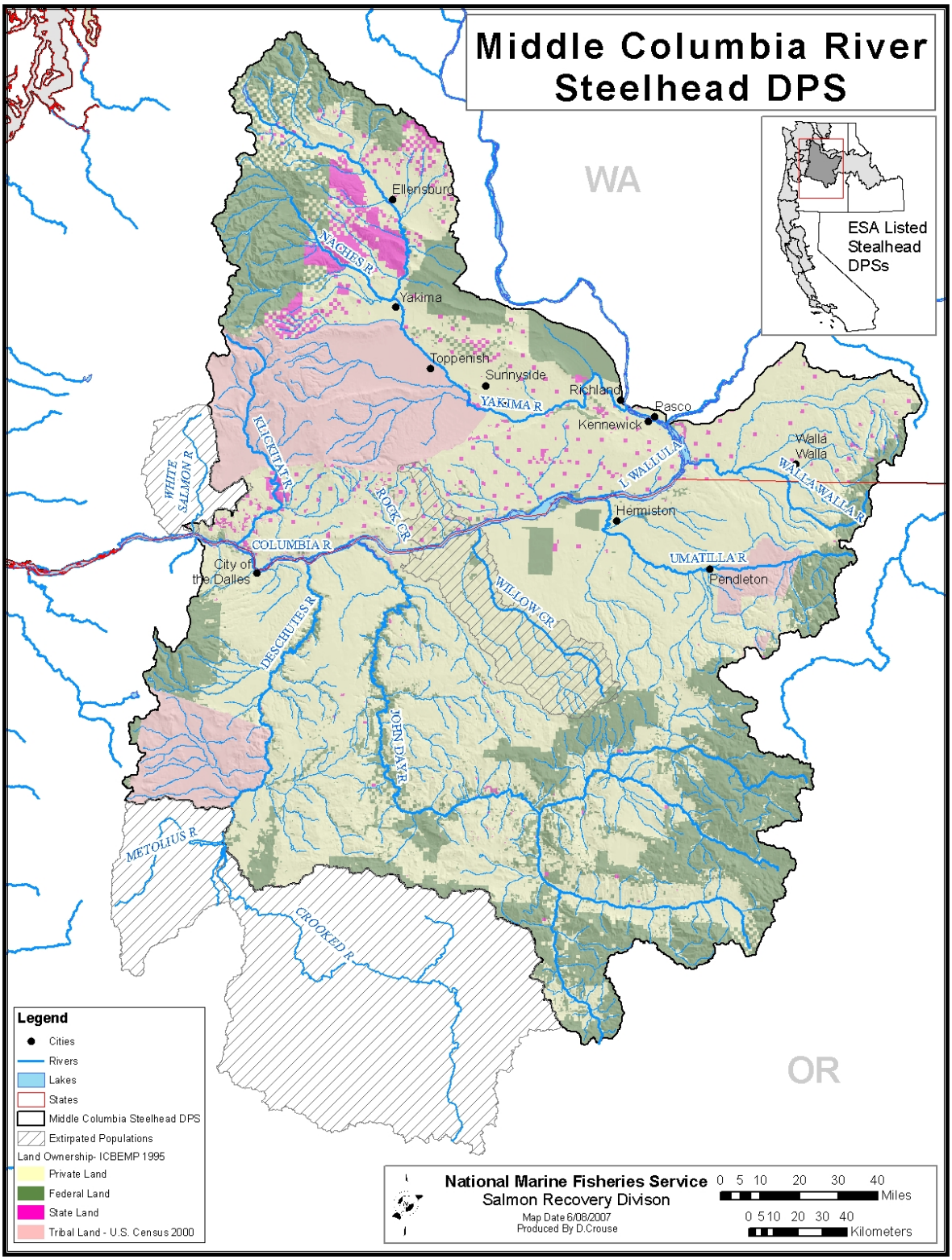


Figure 1-1. Geographic boundaries of the Middle Columbia River Steelhead DPS, showing land ownership.

Human activities have dramatically changed this geography. Although many of the deleterious effects on fish habitat are due to past practices, current human uses of the land and river systems continue to affect steelhead habitat and viability across much of its Middle Columbia range. A growing number of people now recognize the opportunities and benefits of actively protecting and restoring stream corridors, wetlands, stream flows, and other natural features that support native fish and wildlife populations. Management of upland areas is changing to protect or restore watershed function, and cities are undertaking urban watershed protection and restoration. Recovery planning is an opportunity to search for the common ground, to organize protection and restoration of salmonid habitat, and to secure the economic and cultural benefits that accrue to human communities from healthy watersheds and rivers.

The primary goal of ESA recovery plans is for the species to reach the point that it no longer needs the protection of the Act and can be delisted. Recovery plans may also contain "broad sense goals" that go beyond the requirements for delisting to address, other legislative mandates or social, economic, and ecological values. The various locally produced plans contain broad sense goals adopted by local planning entities. These broad sense goals, while stated in slightly different ways, usually share some combination of the following elements: ensuring long-term persistence of viable populations of naturally produced steelhead distributed across their native range; enjoying the social and cultural benefits of meaningful harvest opportunities that are sustainable over the long-term; and pursuing salmon recovery using an open and cooperative process that respects local customs and benefits local communities and economies. Recovery goals and delisting criteria are discussed in greater detail in Chapter 3.

1.1 ESA Requirements

Section 4(f) of the ESA requires that a recovery plan be developed and implemented for species listed as endangered or threatened under the statute.

ESA section 4(a)(1) lists factors for re-classification or delisting that are to be addressed in recovery plans:

A. The present or threatened destruction, modification, or curtailment of [the species'] habitat or range
B. Over-utilization for commercial, recreational, scientific or educational purposes
C. Disease or predation
D. The inadequacy of existing regulatory mechanisms
E. Other natural or human-made factors affecting its continued existence

ESA section 4(f)(1)(B) directs that recovery plans, to the extent practicable, incorporate:

1. a description of such site-specific management actions as may be necessary to achieve the plan's goal for the conservation and survival of the species;
2. objective, measurable criteria which, when met, would result in a determination, in accordance with the provisions of this chapter, that the species be removed from the list; and;
3. estimates of the time required and the cost to carry out those measures needed to achieve the plan's goal and to achieve intermediate steps toward that goal.

In addition, it is important for recovery plans to provide the public and decision makers with a clear understanding of the goals and strategies needed to recover a listed species and the science underlying those conclusions (NMFS Interim Recovery Planning Guidance, October 2004).

Once a species is deemed recovered and therefore removed from a listed status, section 4(g) of the ESA requires the monitoring of the species for a period of not less than five years to ensure that it retains its recovered status.

1.2 How NMFS Intends to Use the Plan

Although recovery plans are not regulatory and their implementation is voluntary, they are important tools that help to do the following:

- Provide context for regulatory decisions.
- Guide decision making by Federal, state, Tribal, and local jurisdictions.
- Provide criteria for status reporting and delisting decisions.
- Organize, prioritize, and sequence recovery actions.
- Organize research, monitoring, and evaluation efforts.

NMFS will encourage Federal agencies and non-Federal jurisdictions to take recovery plans under serious consideration as they make the following sorts of decisions and allocate their resources:

- Actions carried out to meet Federal ESA section 7(a)(1) obligations
- Actions that are subject to ESA sections 4d, 7(a)(2), or 10
- Hatchery and Genetic Management Plans and permit requests
- Harvest plans and permits
- Selection and prioritization of subbasin planning actions
- Development of research, monitoring, and evaluation programs
- Revision of land use and resource management plans
- Other natural resource decisions at the state, Tribal, and local levels

NMFS will emphasize recovery plan information in ESA section 7 (a)(2) consultations, section 10 permit development, and application of the section 4(d) rule by considering:

- The importance of affected populations to listed species viability
- The importance of the action area to affected populations and species viability
- The relation of the action to recovery strategies and management actions
- The relation of the action to the research, monitoring, and evaluation plan for the affected species

In implementing these programs, recovery plans will be used as a reference and a source of context, expectations, and goals. NMFS staff will encourage the Federal "action agencies" to describe in their biological assessments how their proposed actions will affect specific populations and limiting factors identified in the recovery plans, and to describe any mitigating measures and voluntary recovery activities in the action area.

1.3 Middle Columbia Steelhead DPS Geographic Setting

The range of the Middle Columbia steelhead DPS extends over an area of approximately 35,000 square miles in the Columbia plateau of eastern Washington and eastern Oregon. The DPS includes all naturally spawned populations of steelhead in streams from above the Wind River, Washington, and the Hood River, Oregon (exclusive), upstream to, and including, the Yakima River, Washington, excluding steelhead from the Snake River Basin (64 FR 14517; 71 FR 849). The Cascade Mountains form the western border of the plateau in both Oregon and Washington, while the Blue Mountains form the eastern edge. The southern border is marked by the divides that separate the upper Deschutes and John Day basins from the Oregon High Desert and drainages to the south. The Wenatchee Mountains and Palouse areas of eastern Washington border the Middle Columbia on the north.

Temperatures and precipitation vary widely, usually depending on elevation, with cooler and wetter climates in the mountainous areas at the western and eastern boundaries and warmer and drier climates in the lower portions of the watersheds that make up most of the province. The mountainous regions are predominately coniferous forests, while the arid regions are characterized by sagebrush steppe and grassland.

Most of the region is privately owned (64 percent), with the remaining area under Federal (23 percent), tribal (10 percent) and state (3 percent) ownership (Figure 1-1). The landscape, throughout the range of this DPS, is heavily modified for human use, even where populations are low. Most of the landscape consists of are rangeland and timberland, with significant concentrations of dryland agriculture in parts of the range. Irrigated agriculture and urban development are generally concentrated in valley bottoms. Populations in these regions are growing.

1.4 Relationship of Steelhead DPS to Resident *O. mykiss*

"Steelhead" is the name commonly applied to the anadromous (migratory) form of the biological species *Oncorhynchus mykiss*. The common name of the non-anadromous, or resident, form is rainbow trout. When NMFS originally listed the Middle Columbia River steelhead as threatened on March 25, 1999 (64 FR 14517), it was classified as an "evolutionarily significant unit" (ESU) of salmonids that included both the anadromous and resident forms. Recently, NMFS revised its species determinations for West Coast steelhead under the ESA, delineating anadromous, steelhead-only "distinct population segments" (DPS). NMFS listed the Middle Columbia River steelhead DPS as threatened on January 5, 2006 (71 FR 834). Rainbow trout are under the jurisdiction of the U.S. Fish and Wildlife Service (USFWS). This recovery plan addresses steelhead and not rainbow trout, as is consistent with the 2006 ESA listing decision.

NMFS based its DPS determination on the fact that "despite the apparent reproductive exchange between resident and anadromous *O. mykiss*, the two life forms remain 'markedly separated' as a consequence of physical, physiological, ecological, and behavioral factors. . . . Steelhead differ from resident rainbow trout physically in adult size and fecundity, physiologically by undergoing smoltification, ecologically in their preferred prey and principal predators, and behaviorally in their migratory strategy." (71 FR 838).

NMFS acknowledges that the data necessary to evaluate the current status and trends of resident populations are generally lacking, as well as historical data necessary to evaluate trends in abundance and distribution of the two life history forms. NMFS concluded that the collective contribution of the resident life history form to persistence of steelhead is unknown, and may not substantially reduce the overall extinction risk of the steelhead DPS (71 FR 834). Individual management unit plans may identify research and monitoring needs to better understand the status and trends of resident rainbow trout in order to address these data gaps.

1.5 Context of Plan Development

This plan is the product of a collaborative process initiated by NMFS that involves the State of Washington, regional salmon recovery organizations within Washington, the State of Oregon (led by the Oregon Department of Fish and Wildlife, with support from a collaborative sounding board), emerging regional sounding boards within Oregon, other Federal agencies, state agencies, Tribes, local governments, and the public.

While NMFS is directly responsible for ESA recovery planning for salmon and steelhead, NMFS believes that ESA recovery plans for salmon and steelhead should be based on the many state, regional, tribal, local, and private conservation efforts already underway throughout the region. Local support of recovery plans by those whose activities directly affect the listed species, and whose actions will be most affected by recovery efforts, is essential. NMFS therefore supports and participates in locally led collaborative efforts to develop recovery plans that involve local communities, state, tribal, and Federal entities, and other stakeholders.

NMFS developed the Middle Columbia Steelhead DPS recovery plan with assistance from the Middle Columbia Forum (Mid-C Forum), a bi-state group convened by NMFS to provide input on the DPS recovery plan. NMFS developed this Plan by drawing upon the best available scientific information provided by the six regional recovery plans included as appendices to this Plan (i.e. the management unit plans, described below and in Section 1.6.), and by a regional team of scientists (the Interior Columbia Technical Recovery Team, described below). The draft plan went through repeated reviews and revisions in response to comments from both the scientific team and the Mid-C Forum. Participants in the Mid-C Forum include the Oregon Department of Fish and Wildlife (ODFW), Washington Department of Fish and Wildlife (WDFW), the Yakama Nation, Confederated Tribes of the Warm Springs Indian Reservation, Confederated Tribes of the Umatilla Indian Reservation, Washington Governor's Salmon Recovery Office, Oregon Governor's Natural Resources Office, Snake River Salmon Recovery Board, Yakima Basin Fish and Wildlife Recovery Board, US Bureau of Reclamation (BOR), US Fish and Wildlife Service (USFWS), US Forest Service (USFS), US Army Corps of Engineers (COE), Klickitat County, and NMFS Northwest Region.

1.5.1 Recovery Domains and Technical Recovery Teams

Currently, there are 18 ESA-listed ESUs/DPSs of Pacific salmon and steelhead in the Pacific Northwest. NMFS Northwest Region also shares jurisdiction of an additional ESU, Southern Oregon/Northern California coho, with NMFS Southwest Region. For the purpose of recovery planning for these species, NMFS Northwest Region designated five geographically based "recovery domains": Interior Columbia; Willamette-Lower Columbia; Puget Sound and Washington Coast; the Oregon Coast; and the Southern Oregon/Northern California Coast

(Figure 1-2). The range of the Middle Columbia River steelhead DPS is located in the Middle Columbia sub-domain of the Interior Columbia domain (the other Interior Columbia sub-domains are the Snake River and Upper Columbia).

For each domain, NMFS appointed a team of scientists, nominated for their geographic and species expertise, to provide a solid scientific foundation for recovery plans. The charge of each Technical Recovery Team (TRT) is to define ESU/DPS structures, develop recommendations on biological viability criteria for each ESU or DPS and its component populations, provide scientific support to local and regional recovery planning efforts, and provide scientific evaluations of proposed recovery plans. The Interior Columbia TRT (ICTRT) includes biologists from NMFS, states, tribal entities, and academic institutions.

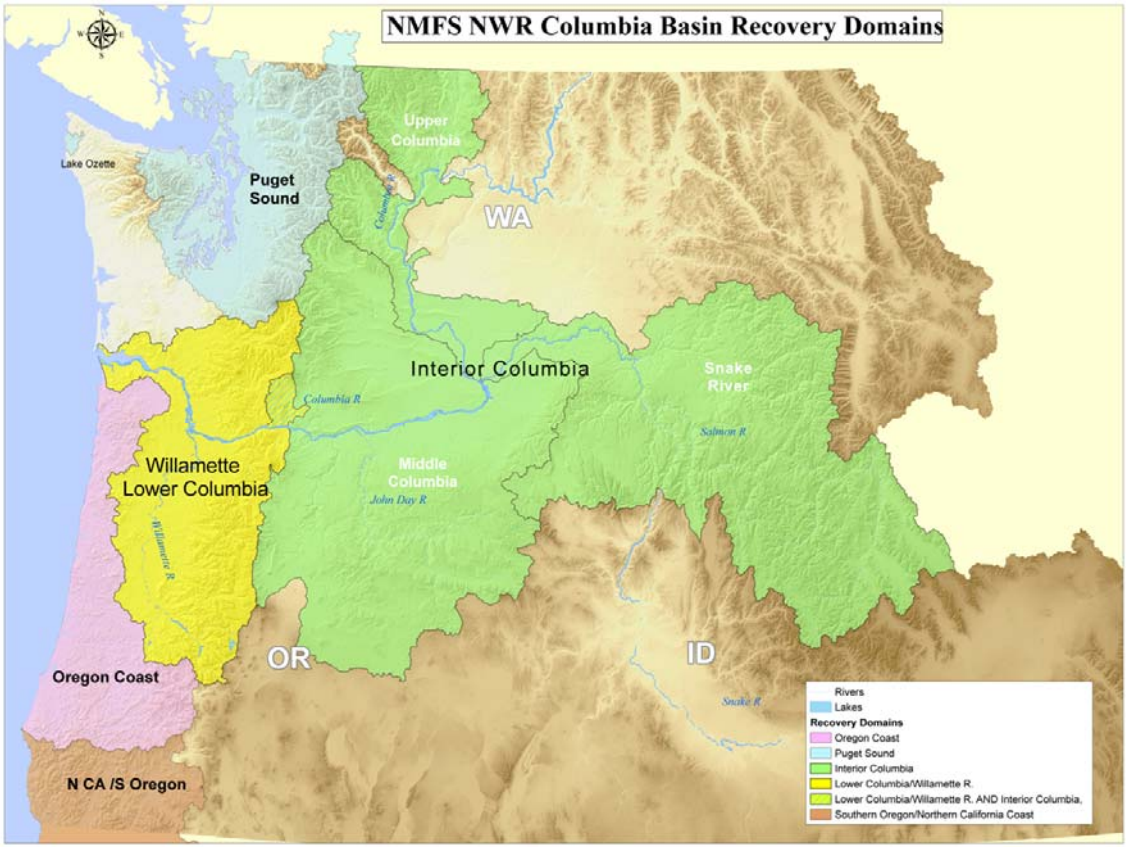


Figure 1-2. Columbia Basin Recovery Domains for NMFS Northwest Region

All the TRTs used the same biological principles for developing their recommendations for ESU/DPS and population viability criteria – criteria to be used, along with criteria based on mitigation of the factors for decline, to determine whether a species has recovered sufficiently to be downlisted or delisted. These principles are described in a NMFS technical memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000). Viable salmonid populations (VSP) are defined in terms of four parameters: abundance, population productivity or growth rate, population spatial structure, and diversity. A viable ESU/DPS is naturally self-sustaining, with a high probability of persistence over a 100-year time period. Each TRT made recommendations using the VSP framework and based on data availability, the unique biological characteristics of the ESUs/DPSs and habitats in the domain,

and the members' collective experience and expertise. Although NMFS has encouraged the TRTs to develop regionally specific approaches for evaluating viability and identifying factors limiting recovery, all the TRTs are working from a common scientific foundation.

1.5.2 Management Units

In each domain, NMFS has worked with state, tribal, local and other Federal entities to develop planning forums that build to the extent possible on ongoing, locally led recovery efforts. NMFS defined "management units" based on jurisdictional boundaries as well as areas where local planning efforts were underway (Figure 1-3). The Middle Columbia management units are (1) Oregon; (2) Washington Gorge, which, in turn, is subdivided into three planning areas, White Salmon, Klickitat, and Rock Creek; (3) Yakima subbasin; and (4) Southeast Washington.

1.6 Management Unit Recovery Plans

Although NMFS has prepared this plan for the entire DPS, the DPS plan's component parts (the management unit plans, Appendices A-F) are the work of citizen groups and county, state, Federal, and tribal entities within the Middle Columbia River region on both sides of the river:

- **Oregon Management Unit:** ***Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment (Oregon Steelhead Recovery Plan) (Appendix A).***

- **Washington Gorge Management Unit:** ***Recovery Plans for the Klickitat (Appendix B), Rock Creek (Appendix C), and White Salmon (Appendix D) subbasin populations of Middle Columbia River steelhead***

- **Yakima Management Unit:** ***Yakima Steelhead Recovery Plan (Appendix E)***

- **Southeast Washington Management Unit:** ***Snake River Salmon Recovery Plan for Southeast Washington (Appendix F)***

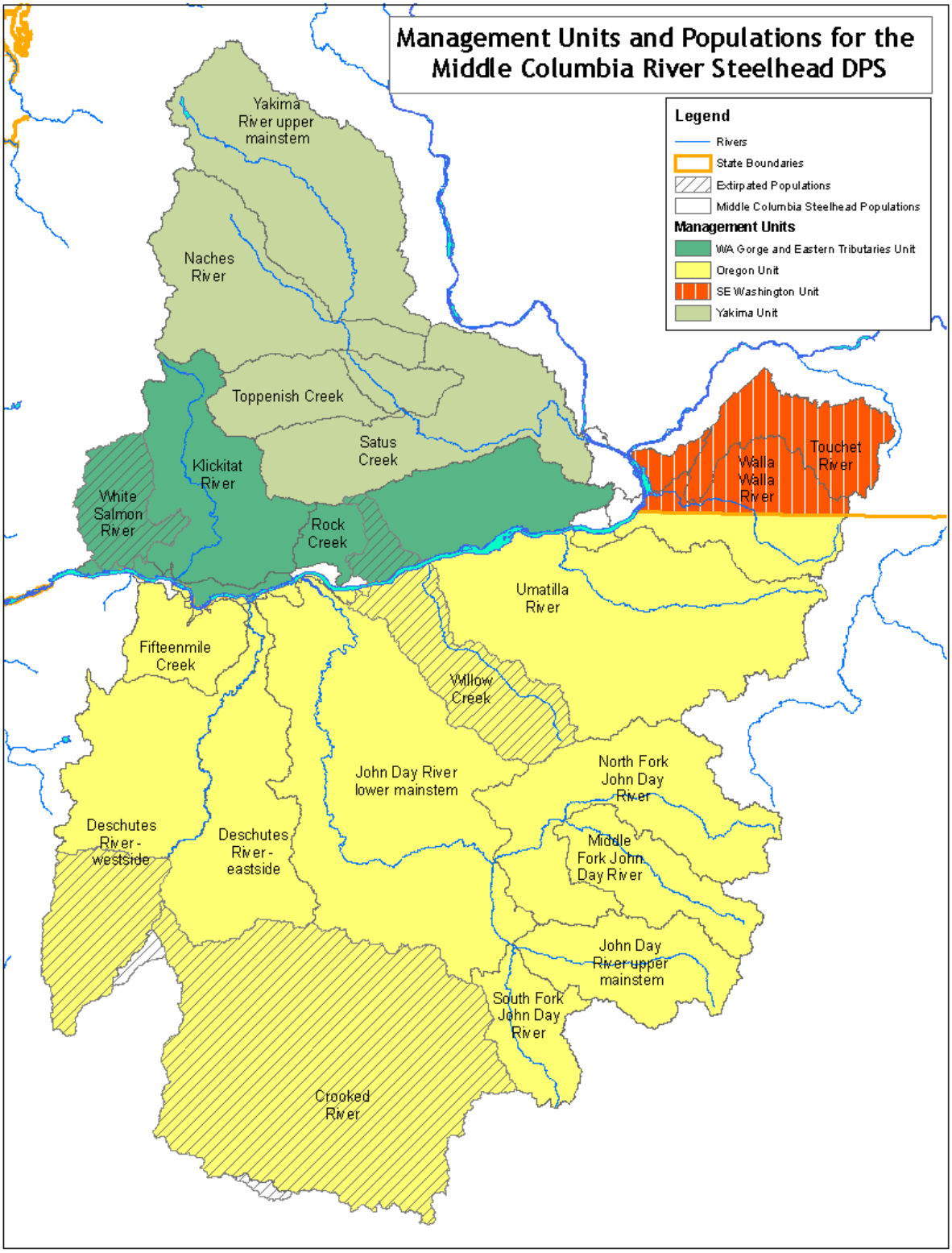


Figure 1-3. Management Units and Populations for the Middle Columbia River Steelhead DPS

1.6.1 Oregon Steelhead Recovery Plan - Appendix A.

ODFW is the lead for the Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment (Oregon Steelhead Recovery Plan). ODFW drew together the Middle Columbia Recovery Planning Team, made up of ODFW staff biologists and representatives from eight other natural resource agencies, and a planning forum, the Mid-Columbia Sounding Board (MCSB). The MCSB is made up of representatives of local communities, agricultural water users, Federal and non-Federal land managers, governing bodies, Tribes, and industry and environmental interests. The role of the MCSB is to provide policy guidance in the development of all aspects of the plan and ensure locally appropriate and locally supported recovery actions needed to achieve species recovery goals. Population-specific management action development teams were drawn from the pool of natural resource agency staff on the Planning Team.

ODFW convened an "Expert Panel" of 12 biologists to examine limiting factors and threats for the 10 independent steelhead populations in Oregon. The recovery planning team also made its own evaluation. More detail on the Expert Panel process is available in the Oregon Steelhead Recovery Plan, Section 8, and in a report by the panel (Mid-C Expert Panel 2006). The Oregon Steelhead Recovery Plan also drew on the relevant subbasin plans, ODEQ reports, NMFS' limiting factors modules, ODFW reports, and other sources.

Oregon Middle Columbia Steelhead Populations:
Fifteenmile Creek
Deschutes River Eastside
Deschutes River Westside
Deschutes/Crooked River (extirpated)
Lower Mainstem John Day
Upper Mainstem John Day
North Fork John Day
Middle Fork John Day
South Fork John Day
Umatilla River
Walla Walla River (also partially in Washington State)
Willow Creek (extirpated)

1.6.2 Washington Gorge Management Unit Recovery Plan (Appendices B, C, and D)

The Washington Gorge Management Unit comprises three subbasins in south-central Washington: the areas drained by the Klickitat River, Rock Creek, and the White Salmon River. The steelhead populations in these subbasins are part of the Cascades Eastern Slope Tributaries major population group. The Washington Gorge Management Unit Recovery Plan (the Washington Gorge Plan) is actually made up of three separate plans, one for each subbasin. Since there is not presently a Washington-State sponsored salmon recovery planning board for this area, NMFS staff drafted the three plans in collaboration with the Yakama Nation, Washington Department of Fish and Wildlife, Klickitat County, the Washington State Governor's Salmon Recovery Office, other Federal agencies, state agencies, local governments, and the public.

The Columbia gorge area within Washington State from Rock Creek east to Kennewick makes up Water Resource Inventory Area (WRIA) 31. The WRIA 31 planning unit is addressing steelhead habitat within the WRIA. The area contains Rock Creek and several smaller tributaries to the Columbia River with current and historical steelhead habitat. The ICTRT has designated steelhead in these smaller tributaries as part of the Willow Creek and Umatilla populations of the Middle Columbia steelhead DPS; however, there is very little further information currently available and no recovery plan was developed for them (see Appendix A to the Rock Creek management unit plan).

The Klickitat basin is in WRIA 30. The WRIA 30 planning unit is addressing steelhead habitat by reviewing water quality proposals developed primarily to fix flow and temperature problems in the Klickitat basin external to the Yakama Reservation. This recovery plan and the Klickitat Recovery Plan may be used by the WRIA 30 planning unit to help guide the review of proposals considered for funding.

The White Salmon River supported an historical population of Middle Columbia River steelhead, which was extirpated from its historical range in 1913 by the construction of Condit Dam at river mile 3.4. In addition, single populations of three listed ESUs of salmon (Lower Columbia River Chinook, Lower Columbia River Coho, and Columbia River Chum) spawn in the White Salmon River subbasin. Condit Dam is scheduled for removal in fall 2009. The White Salmon recovery plan will include discussion of all the listed salmonids that spawn in the White Salmon River; however, the portions of the plan that concern Chinook, coho, and chum will be integrated into the Lower Columbia Fish Recovery Board Salmon Recovery Plan, scheduled to be completed in 2008.

Washington Gorge Steelhead Populations:
Rock Creek
Klickitat
White Salmon (functionally extirpated)[15]

1.6.3 Yakima Steelhead Recovery Plan (Appendix E)

The Yakima Subbasin Fish and Wildlife Planning Board (YSPB) submitted the Draft Yakima Subbasin Salmon Recovery Plan to the Washington State Governor's Salmon Recovery Office on October 26, 2005. In May 2006, NMFS accepted the draft YSPB plan, in combination with a NMFS Supplement regarding the plan, as an Interim Regional Recovery Plan (May 3, 2006, 71 FR 26052). On April 5, 2006, the Yakima Subbasin Fish and Wildlife Planning Board and the Yakima River Basin Salmon Recovery Board were both dissolved by board resolutions. Their functions were then taken on by a new organization, the Yakima Basin Fish and Wildlife Recovery Board (YBFWRB), which includes representatives from the Yakama Nation, Benton, Kittitas, and Yakima counties, and 18 of the 24 municipalities in the Yakima Basin. Since the formation of the YBFWRB, revisions have been made to the original October 2005 draft to incorporate new information, improve clarity, and address issues identified in the NOAA supplement and comments received in response to publication in the Federal Register. A revised

[15] The ICTRT considers extirpated populations to be those that are entirely cut off from anadromy, such as the Crooked River population. Functionally extirpated populations are those of which there are so few remaining numbers that there are not enough fish or habitat in suitable condition to support a fully functional population.

and updated portion of the draft plan, the Yakima Steelhead Recovery Plan, focuses on steelhead recovery needs, and was submitted to NMFS in early 2008 for inclusion in this Middle Columbia Steelhead Recovery Plan. (For more information see www.ybfwrb.org).

Yakima Basin Steelhead Populations:
Satus Creek
Toppenish Creek
Naches River
Upper Yakima River

1.6.4 Snake River Salmon Recovery Plan for Southeast Washington (Appendix F)

The Southeast Washington Recovery Plan was produced by the Snake River Salmon Recovery Board (SRSRB), made up of government and tribal representatives, landowners, and private citizens, funded through the Washington Salmon Recovery Fund. The Board appointed a Regional Technical Team for technical and scientific assistance. In March 2006, NMFS accepted the SRSRB Plan, in combination with a NMFS Supplement regarding the Plan, as an Interim Regional Recovery Plan (March 14, 2006, 71 FR 13094).

Southeast Washington Steelhead Populations:
Walla Walla River (also partially in Oregon)
Touchet River

1.7 Tribal Trust and Treaty Responsibilities

Northwest Indian Tribes have legally enforceable treaty rights reserving to them a share of the salmon harvest. In the Treaties of 1855 between the U.S. government and the Confederated Tribes of the Warm Springs Reservation of Oregon, the Confederated Tribes and Bands of the Yakama Indian Nation, the Confederated Tribes of the Umatilla Indian Reservation, and the Nez Perce Tribe, the tribes, in exchange for the preponderance of their lands, reserved the rights to fish within their reservations and "at all other usual and accustomed places." The usual and accustomed places are understood to include the millions of acres of aboriginal land ceded to the United States in the 1855 treaties, which extends to the Upper Columbia and Snake River basins, and includes most of the geographic range of the Middle Columbia steelhead DPS. A complex history of treaties, executive orders, legislation, and court decisions have culminated in the recognition of tribes as co-managers who share management responsibilities and rights for fisheries in the Columbia Basin.

Achieving the basic purpose of the ESA (to bring the species to the point that it no longer needs the protection of the Act) may not by itself fully meet these rights and expectations, although it will lead to major improvements in the current situation. Ensuring a sufficient abundance of salmon to sustain harvest can be an important element in fulfilling trust and treaty rights as well as garnering public support for these plans. ESA and tribal trust responsibilities complement one another. Both depend on a steady upward trend toward ESA recovery and delisting in the near term, while making aquatic habitat, harvest, and land management improvements for the long-term.

It is appropriate for recovery plans to take these considerations into account and plan for a recovery strategy that includes harvest. In some cases, increases in the naturally spawning populations may be sufficient to support harvest. In others, the recovery strategy may include appropriate use of hatcheries to support a portion of the harvest. So long as the overall plan is likely to achieve the recovery of the listed ESU/DPS, it will be acceptable as a recovery plan.

The NMFS Regional Administrator, in testimony before the U.S. Senate Indian Affairs Committee (June 2003), emphasized the importance of this co-manager relationship: "We have repeatedly stressed to the region's leaders, tribal and non-tribal, the importance of our co-management and trust relationship to the tribes. NMFS enjoys a positive working relationship with our Pacific Northwest tribal partners. We view that relationship as crucial to the region's future success in recovery of listed salmon."

2. BIOLOGICAL BACKGROUND

This chapter summarizes the distribution, life history, and habitat needs of Middle Columbia River steelhead and reviews the basic concepts in salmonid biology needed to understand recovery goals and criteria.

2.1 Steelhead Distribution, Life History, and Habitat

The present distribution of steelhead extends from Kamchatka in Asia, east to Alaska, and down to southern California (NMFS 1999), although the historic range of *O. mykiss* extended at least to the Mexico border (Busby et al. 1996). Middle Columbia River steelhead historically occupied nine major river systems and numerous minor systems on the east side of the Cascades Mountains within the states of Oregon and Washington (see previous Figure 1-1). These major tributaries to the Columbia River are the White Salmon, Deschutes, John Day, Klickitat, Umatilla, Walla Walla, and Yakima Rivers and Fifteenmile Creek and Rock Creek. The John Day River of central Oregon supports the largest naturally spawning, native group of steelhead in the region.

Four artificial propagation programs are considered part of the DPS: the Touchet River Endemic Summer Steelhead Program, the Yakima River Kelt Reconditioning Program, and the Umatilla River and Deschutes River steelhead hatchery programs.

The species *Oncorhynchus mykiss* exhibits perhaps the most complex suite of life history traits of any species of Pacific salmonid. These fish can be anadromous or freshwater residents (and under some circumstances, apparently yield offspring of the opposite form). Steelhead, the anadromous form of *O. mykiss*, are under NMFS jurisdiction, while the resident freshwater forms, usually called "rainbow" or "redband" trout, are under the jurisdiction of the U.S. Fish and Wildlife Service (see further discussion in Section 4.1 of this plan).

Steelhead can spawn more than once (iteroparous), whereas all other *Oncorhynchus* except cutthroat trout (*O. clarki*) spawn once and then die (semelparous). Iteroparity for Columbia Basin steelhead ranges from reported rates of 2-4 percent above McNary Dam (Busby et al. 1996) up to 17 percent in the unimpounded tributaries below Bonneville Dam (at RM 146.1) (Leider et al. 1986).

Within the range of West Coast steelhead, spawning migrations occur throughout the year, with seasonal peaks of activity. The "runs" are usually named for the season in which the peak occurs. Most steelhead can be categorized as one of two run types, based on their sexual maturity when they re-enter freshwater and how far they go to spawn. In the Pacific Northwest, summer steelhead enter freshwater between May and October and require several months to mature before spawning; winter steelhead enter freshwater between November and April with well-developed gonads and spawn shortly thereafter. Summer steelhead usually spawn farther upstream than winter steelhead (Withler 1966, Roelofs 1983, Behnke 1992). Winter steelhead are also called ocean-maturing or coastal type, and summer steelhead, stream-maturing or inland type.

The Middle Columbia River steelhead DPS includes the only populations of inland winter steelhead in the United States, in the Klickitat River, White Salmon River, Fifteenmile Creek, and possibly Rock Creek.[16]

Steelhead spawn in clear, cool streams with suitable gravel size, depth, and current velocity. They may spawn in intermittent streams that provide appropriate conditions for spawning and incubation (Barnhart 1986, Everest 1973). Productive steelhead habitat is characterized by complexity, primarily in the form of large and small wood. Steelhead may enter streams and arrive at spawning grounds weeks or even months before they spawn and are therefore vulnerable to disturbance and predation. They need cover, in the form of overhanging vegetation, undercut banks, submerged vegetation, submerged objects such as logs and rocks, floating debris, deep water, turbulence, and turbidity (Geiger 1973). Summer rearing takes place primarily in the faster parts of pools, although young-of-the-year are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types (Bambrick et al. 2004) (Table 2-1). Depending on water temperature, steelhead eggs may incubate for 1.5 to 4 months before hatching.

Table 2-1. Key habitat requirements by life stage and time period for steelhead.

Life Stage	Relevant Months	Key Habitat Descriptions
Spawning	Mar-Jun	Riffles, tailouts, and glides containing a mixture of gravel and cobble sizes with flow of sufficient depth for spawning activity.
Incubation	Mar-Jun	Riffles, tailouts, and glides as described for spawning, with sufficient flow for egg and alevin development.
Fry Colonization	May-Jul	Shallow, slow velocity areas within the stream channel, often associated with stream margins.
Active Rearing	0-age May-Jul; 1-age, Mar-Oct; 2+-age, Mar-Oct	Gravel and cobble substrates with sufficient depth and velocity, and boulder/large cobble/wood obstruction to reduce flow and concentrate food.
Inactive Rearing	0,1-age Oct-Mar	Stable cobble/boulder substrates with interstitial spaces.
Migrant	1-age, Mar-Jun 2+-age, Mar-Jun	All habitat types having sufficient flow for free movement of juvenile migrants.
Prespawning Migrant	Winter, Nov-Apr Summer, All	All habitat types having sufficient flow for free movement of sexually mature adult migrants.
Prespawning Holding	Winter, Dec-May Summer, All	Relatively slow, deep water habitat types typically associated with (or immediately adjacent to) the main channel.

Young steelhead typically rear in streams for some time before migrating to the ocean as smolts. Steelhead smolts have been shown to migrate at ages ranging from 1 to 5 years throughout the

[16] See Rock Creek Recovery Plan p. 49

Columbia Basin, but most steelhead generally smolt after 2 years in freshwater (Busby et al. 1996). Some juveniles move downstream to rear in larger tributaries and mainstem rivers.

Based on catch data, juvenile steelhead tend to migrate directly offshore during their first summer, rather than migrating nearer to the coast. Maturing Columbia River steelhead are found off the coast of Northern British Columbia and west into the North Pacific Ocean (Busby et al. 1996). Available fin-mark and coded-wire tag data suggest that winter steelhead tend to migrate farther offshore but not as far north into the Gulf of Alaska as summer steelhead (Burgner et al. 1992). At the time adults are (re-)entering freshwater, tagging data indicate that immature Columbia River steelhead are out in the mid-North Pacific Ocean.

Most steelhead spend 2 years in the ocean (range 1 to 4 years) before migrating back to their natal streams (Shapovalov and Taft 1954; Narver 1969; Ward and Slaney 1988). Once in the river, steelhead apparently rarely eat and grow little, if at all. These combined behaviors produce fish that range between 3 and 7 years of age at the time of spawning.

2.2 ESU/DPS Biological Structure

Salmonid species' homing propensity (their tendency to return to the locations where they originated) creates unique patterns of genetic variation and connectivity that mirror the distribution of their spawning areas across the landscape. Diverse genetic, life history, and morphological characteristics have evolved over generations, creating runs highly adapted to diverse environments. It is this variation that gives the species as a whole the resilience to persist over time.

Historically, a salmon ESU or steelhead DPS typically contained multiple populations connected by some small degree of genetic exchange by straying spawners. Thus, the overall biological structure of the ESU/DPS is hierarchical; spawners in the same area of the same stream will share more characteristics than those in the next stream over. Fish whose natal streams are separated by hundreds of miles will have less genetic similarity. The ESU or DPS is essentially a metapopulation defined by the common characteristics of populations within a geographic range. Recovery planning efforts focus on this biologically based hierarchy, which reflects the apparent degree of connectivity between the fish at each geographic and conceptual level (Figure 2-1).

McElhany et al. (2000) formally identified two levels in this hierarchy for recovery planning purposes: the evolutionarily significant unit (ESU) or distinct population segment (DPS) and the independent population. The ICTRT identified an additional level between the population and ESU/DPS levels, which they call a major population group (MPG) (McClure et al. 2003).

2.2.1 Evolutionarily Significant Units/Distinct Population Segments

An ESU or DPS is a distinctive group of Pacific salmon or steelhead that is uniquely adapted to a particular area or environment and cannot be replaced. Because of the hierarchical structure of salmonid populations, the concept of "distinctive group" has received considerable attention and refinement. An ESU is defined as a group of Pacific salmon that is "substantially reproductively isolated from other conspecific units and represents an important component of the evolutionary legacy of the species" (Waples 1991). A "population segment" is considered distinct (a DPS and hence a "species" for purposes of conservation under the ESA) if it is discrete from and

significant to the remainder of its species based on factors such as physical, behavioral, or genetic characteristics, it occupies an unusual or unique ecological setting, or its loss would represent a significant gap in the species' range.

ESUs/DPSs may contain multiple populations that are connected by some degree of migration, and hence may have a broad geographic range across watersheds and river basins.[17]

2.2.2 Major Population Groups

Within an ESU/DPS, independent populations can be grouped into larger populations that share similar genetic, geographic, and/or habitat characteristics (McClure et al. 2003). These "major groupings" of populations (MPGs) are isolated from one another over a longer time scale than that defining the individual populations, but retain some degree of connectivity greater than that between ESUs/DPSs. The relationship between ESU/DPS, MPG, and independent populations is depicted in Figure 2-1.

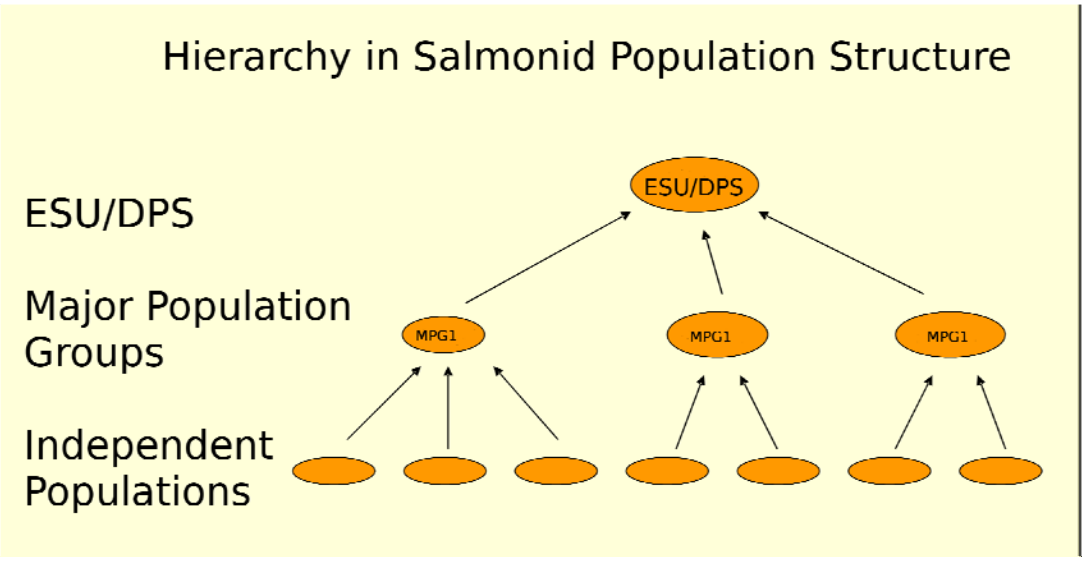


Figure 2-1 Hierarchical levels of salmonid species structure as defined by the TRTs for ESU/DPS recovery planning.

[17] See Section 4.2 for discussion of the relationship of anadromous vs resident *O. mykiss.*

2.2.3 Independent Populations

McElhany et al. (2000) defined an independent population as follows:

> *"…a group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place at a different season. For our purposes, not interbreeding to a 'substantial degree' means that two groups are considered to be independent populations if they are isolated to such an extent that exchanges of individuals among the populations do not substantially affect the population dynamics or extinction risk of the independent populations over a 100-year time frame."*

2.3 Middle Columbia River Steelhead Populations and MPGs

The ICTRT (McClure et al. 2003) identified 20 historical populations of Middle Columbia steelhead, shown in Figure 2-2. This identification was based on genetic information, geography, life history traits, morphological traits, and population dynamics. Seventeen of these populations are extant, and three extirpated (White Salmon River, Deschutes Crooked River above Pelton Dam, and Willow Creek).

Three hatchery programs produce steelhead that are considered to be part of the DPS: the Round Butte hatchery program on the Deschutes River, the Umatilla River hatchery program, and the endemic summer steelhead program on the Touchet River (71 FR 834). In addition, a program to improve kelt (post-spawned adult) survival for the four Yakima Basin populations is also considered part of the DPS. Within the range of the Middle Columbia steelhead DPS, nonlisted hatchery steelhead are released into the Klickitat basin, the Walla Walla (on the Washington side), the Touchet, and the White Salmon to support harvest.

The ICTRT stratified the Middle Columbia River steelhead populations into MPGs based on ecoregion characteristics, life history types, and other geographic and genetic considerations. It identified four MPGs: Cascades Eastern Slope Tributaries, Yakima Basin, John Day Basin, and Umatilla/Walla Walla. The John Day River MPG is wholly within Oregon and the Yakima Basin MPG is wholly within Washington. The other two include populations on both sides of the Oregon/Washington boundary (see Figure 2-3). The management units that NMFS defined for planning purposes do not cross state boundaries; thus, the two bi-state MPGs have populations in different management units. The headwaters of the Walla Walla River are in Oregon and the river joins the Columbia in Washington, but the Walla Walla River steelhead are functionally one population, covered in two management unit plans.

2.3.1 Cascades Eastern Slope Tributaries MPG

The Cascade Eastern Slope Tributaries MPG includes three extant steelhead populations in Oregon and two in Washington, with one extirpated population in each state. This MPG has a geographically complex range, embracing one major river system – the Deschutes – and several smaller subbasins on both sides of the river. The Oregon populations are covered in the Oregon Steelhead Recovery Plan and the Washington populations in the Washington Gorge Management Unit plans. The Deschutes subbasin stretches over 10,700 square miles of land in central Oregon

and covers 11 percent of Oregon's land area. Deschutes County, with the cities of Bend, Redmond, and Sisters, and Crook County, with Madras and Prineville, are among the fastest growing counties in the nation. The Confederated Tribes of Warm Springs Indian Reservation of approximately 641,000 acres includes several tributaries of the Deschutes and is bordered to the south and east by the mainstem Deschutes and the Round Butte dam complex. The Washington Gorge populations are in rural areas with agricultural development in the lowlands and forest uses in the uplands. The headwaters of the Klickitat River are within the Yakama Reservation.

2.3.2 John Day River MPG

The John Day River steelhead populations are currently managed entirely as wild populations. The John Day Basin is wholly within Oregon. The John Day River, which flows west from the Blue Mountains and then north through a deeply carved, basaltic landscape, is the second-longest free-flowing river in the continental United States. The towns within the subbasin with the largest populations are John Day, Prairie City, and Condon, all with less than 2000 residents. The largest tributary to the John Day River is the North Fork, which originates in the Wallowa-Whitman National Forest in the Blue Mountains at elevations near 8000 feet. The North Fork John Day River flows westerly for 112 miles and joins the mainstem near Kimberly (RM 185), 15 miles below the town of Monument.

2.3.3 Umatilla/Walla Walla MPG

The Umatilla River is in Oregon, the Touchet River in Washington, and the Walla Walla River in both states. The Umatilla River originates in the Blue Mountains of northeastern Oregon and flows north and west to enter the Columbia River at river mile (RM) 289. The towns of Pendleton, Hermiston, and Umatilla are located along the Umatilla mainstem. The Confederated Tribes of the Umatilla Indian Reservation comprises 271 square miles on both sides of the river. Aside from the towns, land use is mostly dryland and irrigated agriculture.

The Walla Walla River also originates in Oregon and flows northwest into Washington to join the Columbia, while the Touchet originates in the Blue Mountains on the Washington side and flows south and west into the Walla Walla. The river valley is extensively and intensively irrigated, with timber harvest in the high and mid elevations. Settlements include the city of Walla Walla, population 26,500, on Mill Creek, a tributary of the Walla Walla River, and the smaller towns of College Place, Dayton, and Waitsburg, Washington, and Milton Freewater, Oregon.

This MPG also includes several small tributaries (Chapman, Wood Gulch, Pine, Old Lady, Alder and Glade Creeks) located east of Rock Creek in Washington State that drain into the Columbia upstream of John Day Dam. The ICTRT has determined that four of these eastern Washington tributaries are minor spawning areas of the extirpated Willow Creek population – Pine Creek, Wood Creek, Old Lady Creek and Chapman Creek. Data needs to be collected regarding steelhead use in these small tributaries of the Columbia.

2.3.4 Yakima River MPG

The Yakima River MPG is wholly within Washington State. Cities and towns along the Yakima River include Cle Elum and Ellensburg in Kittitas county, Yakima and several smaller towns in Yakima County, and Prosser and Richland along the lower river in Benton County. The lowlands are extensively developed for irrigated agriculture, though significant amounts of complex floodplain habitat remain. Interstate highway 82 follows the river for about two-thirds of its length and scenic highways follow the Naches and Tieton rivers. The least developed areas are the uplands in the Eastern Cascade Mountains and the Satus Creek subbasin on the Yakama Indian Reservation. The population of the Yakima basin is approximately 300,000.

The Yakima subbasin is growing in population and most likely will continue to grow, and planners expect that the bulk of land use and development for future population growth will occur in proximity to the Yakima River mainstem and major tributary corridors where there is water, an existing core of rail and road transportation infrastructure, major concentrations of urban services, and high-value shoreline property.

Water storage and delivery systems have major impacts on the basin's hydrology. An extensive water supply system run by the Bureau of Reclamation's Yakima Irrigation Project stores and delivers water for over 400,000 acres of irrigated agriculture and, to a lesser degree, industrial, domestic, and hydropower use. Management of water storage and delivery systems results in streamflows across the subbasin that are often out of phase with the life history requirements of native salmonids (Fast et al. 1991; Stanford, Snyder et al. 2002) and riparian species such as cottonwoods (Braatne and Jamieson 2001).

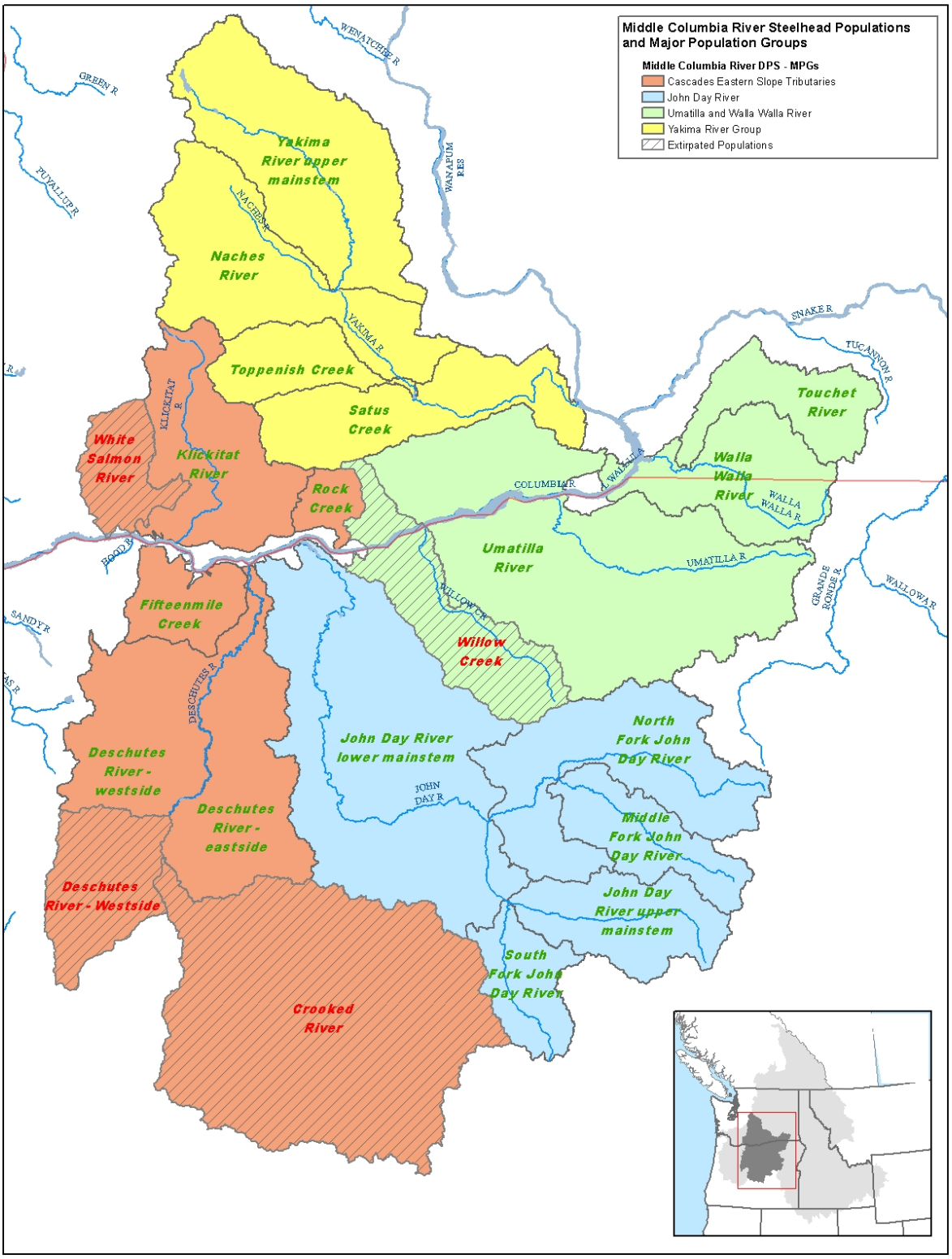


Figure 2-2 Middle Columbia River Steelhead Populations and Major Population Groups.

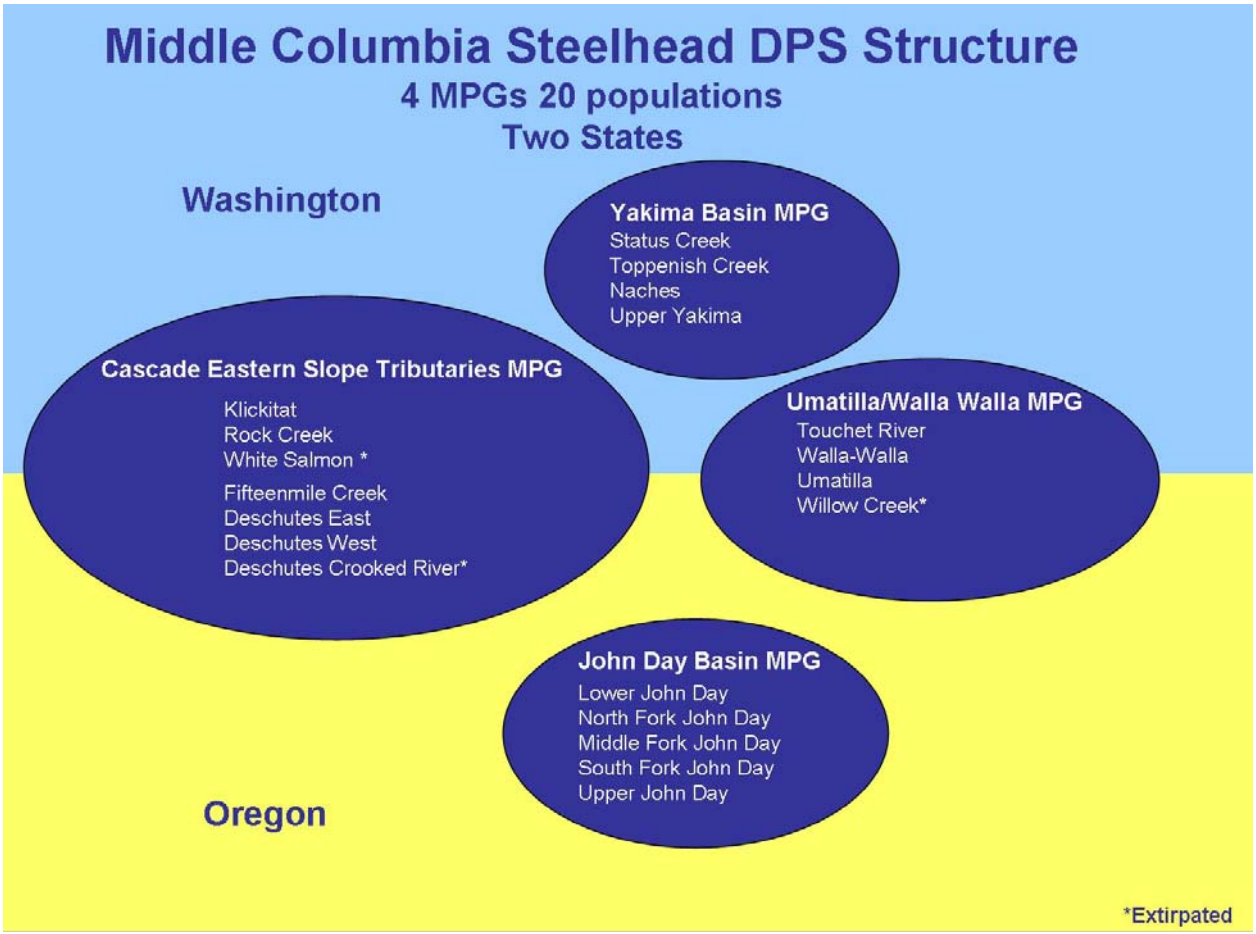


Figure 2-3 Middle Columbia Steelhead DPS Structure

2.4 Viable Salmonid Populations

NMFS scientists measure salmon recovery in terms of four parameters, called the viable salmonid population (VSP) parameters: abundance, productivity, spatial structure, and diversity (McElhany et al. 2000).

2.4.1 Abundance and Productivity

Abundance refers to spawners (adults on the spawning ground), measured over a time series, i.e. some number of years. The ICTRT often uses a recent 10- or 12-year geometric mean of natural spawners as a measure of current abundance.

The productivity of a population (the average number of surviving offspring per parent) is a measure of the population's ability to sustain itself. Productivity can be measured as spawner:spawner ratios (returns per spawner or recruits per spawner) (or adult progeny to parent), annual population growth rate, or trends in abundance. Population-specific estimates of abundance and productivity are derived from time series of annual estimates, typically subject to a high degree of annual variability and sampling-induced uncertainties. The ICTRT recommends estimating current intrinsic productivity using spawner-to-spawner return pairs from low to moderate escapements over a recent 20-year period.

Abundance and productivity are linked, as populations with low productivity can still persist if they are sufficiently large, and small populations can persist if they are sufficiently productive. A viable population needs sufficient abundance to maintain genetic health and to respond to normal environmental variation, and sufficient productivity to enable the population to quickly rebound from periods of poor ocean conditions or freshwater perturbations.

The VSP guidelines for abundance recommend that a viable population should be large enough to have a high probability of surviving environmental variation observed in the past and expected in the future; be resilient to environmental and anthropogenic disturbances; maintain genetic diversity; and support/provide ecosystem functions (McElhany et al. 2000).

Viable populations should demonstrate sufficient productivity to support a net replacement rate of 1:1 or higher at abundance levels established as long-term targets. Productivity rates at relatively low numbers of spawners should, on the average, be sufficiently greater than 1.0 to allow the population to rapidly return to abundance target levels. (ICTRT 2005)

The ICTRT considers populations with fewer than 500 individuals at high risk for inbreeding depression and a variety of other genetic concerns (McClure et al. 2003). Because of this, it considers any population fewer than 500 individuals to be minimally viable, regardless of its intrinsic productivity.

Abundance should be high enough that 1) declines to critically low levels would be unlikely, assuming recent historical patterns of environmental variability and intrinsic productivity; 2) compensatory processes provide resilience to the effects of short-term perturbations; and 3) subpopulation structure is maintained (e.g., multiple spawning tributaries, spawning patches, life history patterns) (ICTRT 2005).

2.4.2 Spatial Structure and Diversity

Spatial structure and diversity considerations are combined in the evaluation of a salmonid population's status because they often overlap. A population's spatial structure is made up of both the geographic distribution of individuals in the population and the processes that generate that distribution (McElhany et al. 2000, p. 18). Diversity refers to the distribution of traits within and among populations. Some traits are completely genetically based, while others, including nearly all morphological, behavioral, and life history traits, vary as a result of a combination of genetic and environmental factors (ibid., p. 19).

Populations with restricted distribution and few spawning areas are at a higher risk of extinction as a result of catastrophic environmental events, such as a landslide, than are populations with more widespread and complex spatial structures. A population with a complex spatial structure, including multiple spawning areas, experiences more natural exchange of gene flow and life history characteristics.

Population-level diversity is similarly important for long-term persistence. Populations exhibiting greater diversity are generally more resilient to short-term and long-term environmental changes. Phenotypic diversity, which includes variation in morphology and life

history traits, allows more diverse populations to use a wider array of environments, and protects populations against short-term temporal and spatial environmental changes. Underlying genetic diversity provides the ability to survive long-term environmental changes.

Because neither the precise role that diversity plays in salmonid population viability nor the relationship of spatial processes to viability is completely understood, the ICTRT adopted the principle from McElhany et al. that historical spatial structure and diversity should be taken as a "default benchmark," on the assumption that historical, natural populations did survive many environmental changes and therefore must have had adequate spatial structure and diversity.

The ICTRT defined two goals, or biological or ecological objectives, that spatial structure and diversity criteria should achieve:

- Maintaining natural rates and levels of spatially mediated processes. This goal serves (1) to minimize the likelihood that populations will be lost due to local catastrophe, (2) to maintain natural rates of recolonization within the population and between populations, and (3) to maintain other population functions that depend on the spatial arrangement of the population.

- Maintaining natural patterns of variation. This goal serves to ensure that populations can withstand environmental variation in the short and long terms (ICTRT 2007a).

2.5 Population Size

The ICTRT developed criteria for characterizing the relative size and complexity of Interior Columbia Basin steelhead populations based on their analysis of the intrinsic or historical potential habitat available to the population (ICTRT 2005). This analysis used available Geographic Information System (GIS) data layers showing stream characteristics (e.g. channel width, gradient, valley confinement) and empirically derived relationships between habitat type, stream structure, landscape processes, and spawning. The ICTRT built a model that also incorporated information from local biologists and recovery planners to identify natural barriers to migration and other local variations (ICTRT 2007a).

Middle Columbia steelhead spawn in a wide range of tributary drainage areas, from small creeks, e.g. Fifteenmile Creek or Rock Creek, to very large rivers, such as the Lower John Day. The ICTRT categorized historical population sizes as Basic, Intermediate, Large, and Very Large, and set minimum abundance thresholds for viable steelhead populations of each type (Table 2-2). The abundance thresholds are associated with minimum productivity thresholds, based on modeling studies described in ICTRT 2007a and 2007b. As explained in Section 2.4.1, abundance and productivity are linked, within limits; above a certain threshold, higher productivity can compensate for lower abundance and vice versa.

Table 2-2. Abundance and Productivity for Viable Population by Size Category

Size Category	Minimum Abundance Threshold	Minimum Productivity Threshold
Basic	500	1.56
Intermediate	1000	1.35
Large	1500	1.26
Very Large	2,250	1.19

Of the 20 Middle Columbia steelhead populations (including the three extirpated populations), 5 are categorized as Basic, 8 as Intermediate, 5 as Large, and 2 as Very Large (ICTRT 2007a). Table 2-3 shows the minimum abundance and productivity thresholds for the Middle Columbia steelhead populations to have a 95 percent probability of persistence for the next 100 years.

Table 2-3. Middle Columbia steelhead size categories (ICTRT 2007)

Major Population Grouping	Population	Population Size	Abundance Threshold	Productivity Threshold
Cascade Eastern Slope Tributaries	White Salmon (functionally extirp.)	Basic	500	1.56
	Klickitat R.	Intermediate	1000	1.35
	Fifteenmile Cr.	Basic	500	1.56
	Deschutes R. East	Intermediate	1000	1.35
	Deschutes R. West	Large[1]	1500	1.26
	Rock Cr.	Basic	500	1.56
	Crooked River (Extirp.)	Very Large	2250	1.19
John Day River	Lower Mainstem JD	Very Large	2250	1.19
	North Fork John Day	Large	1500	1.26
	Middle Fork John Day	Intermediate	1000	1.35
	South Fork John Day	Basic	500	1.56
	Upper Mainstem JD	Intermediate	1000	1.35
Umatilla / Walla Walla Rivers	Umatilla R.	Large	1500	1.26
	Walla Walla R.	Intermediate	1000	1.35
	Touchet R.	Intermediate	1000	1.35
	Willow Crk. (Extirp.)	Intermediate	1000	1.35
Yakima River Group	Satus Cr.	Intermediate[18]	1000	1.35
	Toppenish Cr.	Basic	500	1.56
	Naches R.	Large	1500	1.26
	Upper Yakima	Large	1500	1.26

[1]This population is treated as Intermediate in size with respect to abundance and productivity criteria because of constraints to currently accessible habitat (i.e. Pelton Dam).

[18] For the historical population analysis, the ICTRT included the mainstem Yakima habitat below the confluence of Satus Creek in the Satus Creek population, making it Intermediate in size. However, if the mainstem component is lumped instead with mainstem Yakima River habitat upstream of Satus, the Satus Creek population would drop to Basic size. The Yakima plan discusses this question in more detail.

2.6 Critical Habitat

The ESA requires the Federal government to designate "critical habitat" for any species it lists under the ESA. The Act defines critical habitat as areas that contain physical or biological features that are essential for the conservation of the species, and that may require special management or protection. Critical habitat designations must be based on the best scientific information available, in an open public process, within specific timeframes. On September 2, 2005 NMFS published a final rule (70 FR 52630, NMFS 2005b) to designate critical habitat for Middle Columbia River steelhead and 12 other ESUs/DPSs of salmon and steelhead (Figure 2-4). The final rule took effect on January 2, 2006.

A critical habitat designation does not set up a preserve or refuge, and critical habitat requirements do not apply to citizens engaged in activities on private land that do not involve a Federal agency. The designation applies only when Federal funding, permits, or projects are involved. Under section 7 of the ESA, all Federal agencies must ensure that any actions they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species, or destroy or adversely modify its designated critical habitat. Before critical habitat is designated, careful consideration must be given to its economic impacts, impacts on national security, and other relevant impacts. The Secretary of Commerce may exclude an area from critical habitat if the benefits of exclusion outweigh the benefits of designation, unless excluding the area will result in the extinction of the species concerned.

For anadromous fish, the essential features of designated critical habitat include substrate, water quality, water quantity, water temperature, food, riparian vegetation, access, water, velocity, space, and safe passage. These features also describe the habitat factors associated with viability for all ESUs/DPSs. The specific habitat requirements for each ESU/DPS differ by life history type and life stage.

NMFS' Critical Habitat Assessment Review Team (Bambrick et al. 2004) rated the conservation value of all watersheds supporting populations of Middle Columbia River steelhead. The team identified the "primary constituent elements" of critical habitat for steelhead, i.e., the physical and biological elements that support one or more life stages and are considered essential to the conservation of the species (Table 2-4).

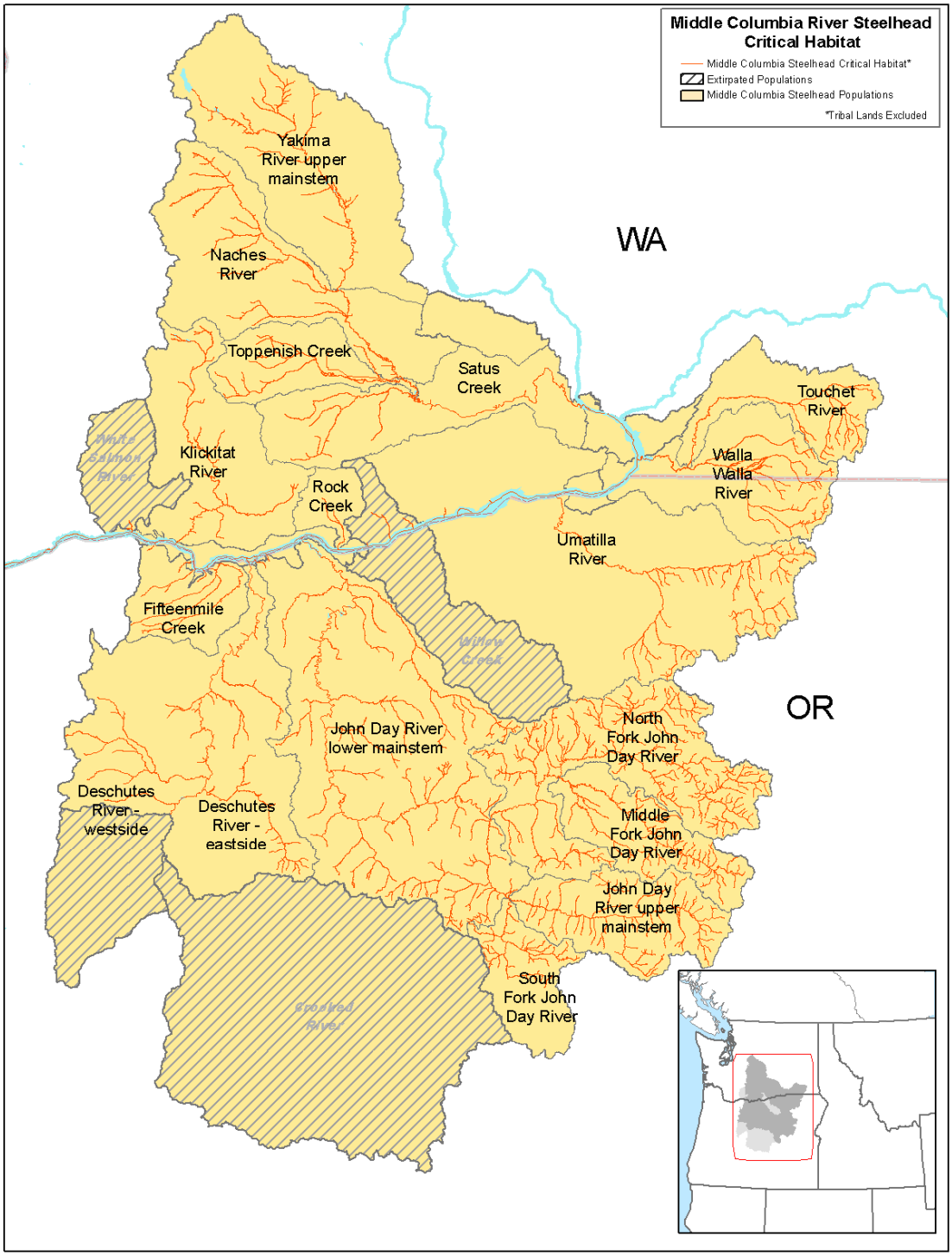


Figure 2-4. Middle Columbia Steelhead Critical Habitat[19] (NMFS 2005b)

[19] Critical habitat designation does not apply to the streams or stream reaches that are on tribal lands. However, the pattern of tribal vs nontribal ownership is too complex to differentiate at the scale of this map.

Table 2-4 Types of sites and essential physical and biological features designated as PCEs for steelhead, and the life stage each PCE supports.

Site	Essential Physical and Biological Features	ESU/DPS Life Stage
Freshwater spawning	Water quality, water quantity, and substrate	Spawning, incubation, and larval development
Freshwater rearing	Water quantity and floodplain connectivity	Juvenile growth and mobility
	Water quality and forage	Juvenile development
	Natural cover[a]	Juvenile mobility and survival
Freshwater migration	Free of artificial obstructions, water quality and quantity, and natural cover[b]	Juvenile and adult mobility and survival
Estuarine areas	Free of obstruction, water quality and quantity, and salinity	Juvenile and adult physiological transitions between salt and freshwater
	Natural cover,[a] forage,[b] and water quantity	Growth and maturation
Nearshore marine areas	Free of obstruction, water quality and quantity, natural cover,[a] and forage[b]	Growth and maturation, survival
Offshore marine areas	Water quality and forage[b]	Growth and maturation

[a] Natural cover includes shade, large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

[b] Forage includes aquatic invertebrate and fish species that support growth and maturation.

NMFS recognizes that salmon habitat is dynamic and that present understanding of areas important for conservation will likely change as recovery planning sheds light on areas that can and should be protected and restored, such as areas upstream of barriers where steelhead could be re-established into historical habitat. One example is the area upstream of Pelton Dam, of which the final rule designating critical habitat stated,

> " . . . the CHART agreed with the comments that areas upstream of Pelton Dam may be essential for this ESU as well, citing recent efforts to re-establish steelhead into historical habitat above this dam. However . . . at the present time we do not have information allowing us to determine that the specific areas within the geographical area occupied by the species are inadequate for conservation, such that we can make a determination that currently unoccupied areas above dams are essential for conservation. We will revise the designation if ongoing recovery planning indicates that specific areas above these dams warrant designation as critical habitat." (70 FR 52630, September 2, 2005, NMFS 2005a).

NMFS will update its critical habitat designations as needed, based on information developed during recovery plan implementation. Critical habitat designations are one element to consider in identifying and prioritizing recovery actions.

3. RECOVERY GOALS AND DELISTING CRITERIA

In this chapter we describe in greater detail the recovery goals in the management unit plans and the delisting criteria NMFS will use in future reviews of the Middle Columbia steelhead DPS. The recovery goals that are incorporated into a locally developed recovery plan may include delisting, reclassification (e.g., from endangered to threatened), and/or other "broad sense" goals. The delisting criteria are a NMFS determination and may include both technical and policy considerations. Delisting criteria must meet the ESA requirements, while recovery may be defined more broadly. A third "term of art" used in this recovery plan is recovery "scenarios" (Section 3.3). Recovery scenarios are combinations of viability status for individual populations within the DPS that will meet the ICTRT criteria for overall DPS viability.

The ESA requires that recovery plans, to the maximum extent practicable, incorporate objective, measurable criteria which, when met, would result in a determination in accordance with the provisions of the ESA that the species be removed from the Federal List of Endangered and Threatened Wildlife and Plants (50 CFR 17.11 and 17.12). These criteria are of two kinds: the biological viability criteria, which deal with population or demographic parameters, and the "threats" criteria, which relate to the five listing factors detailed in the ESA (see Sections 1.3 and 3.4 of this Plan). The threats criteria define the conditions under which the listing factors, or threats, can be considered to be addressed or mitigated. Together these make up the "objective, measurable criteria" required under section 4(f)(1)(B) for the delisting decision.

The delisting criteria are based on the best available scientific information and incorporate the most current understanding of the DPS and the threats it faces. As this recovery plan is implemented, additional information will become available that can increase certainty about whether the threats have been abated, whether improvements in population and DPS status have occurred, and whether linkages between threats and changes in salmon status are understood. These criteria will be assessed through an adaptive management program under development for the Plan, and NMFS will thoroughly review the criteria during its 5- and 10-year status reviews of the DPS.

For these status reviews, NMFS intends to rely strongly on the advice of the TRTs and recommendations of local recovery boards. However, NMFS has ultimate responsibility for final recovery plans and delisting decisions, and must take into account all relevant information, including, but not limited to, biological and policy considerations developed in the recovery planning process. NMFS has clarified, through Federal Register Notices on interim and proposed recovery plans, how it applies the TRT products to the plans (e.g., 71 FR 13094, Availability of ESA Draft Snake River Salmon Recovery Plan for Southeast Washington and Supplement to that draft; 71 FR 26052, Availability of Draft Yakima Subbasin Salmon Recovery Plan; 72 FR 57303, Adoption of ESA Recovery Plan for Upper Columbia Spring Chinook and Steelhead).

3.1 Biological Viability Criteria

In 2007, the ICTRT completed its Technical Review Draft of *Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs* (ICTRT 2007a). Biological viability criteria are quantitative metrics that describe DPS characteristics associated with a low risk of extinction for the foreseeable future. These criteria are based on the VSP parameters of abundance, productivity, spatial distribution, and diversity, according to guidelines developed by NOAA's

Northwest Fisheries Science Center and published as a NOAA Technical Memorandum, *Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units* (McElhany et al. 2000, ICTRT 2007a). The ICTRT calculated varying levels of risk of extinction and related the risk levels to their criteria.

3.1.1 DPS Viability

Since MPGs are geographically and genetically cohesive groups of populations, they are critical components of ESU/DPS spatial structure and diversity. Having all MPGs within an ESU/DPS at low risk provides the greatest probability of persistence for the ESU/DPS. The DPS viability criterion defined by the ICTRT (ICTRT 2007a) is as follows:

All extant MPGs and any extirpated MPGs critical for proper functioning of the ESU/DPS[20] should be at low risk.

The ICTRT explains that the major objectives of the ESU/MPG-level viability criteria are to ensure preservation of basic historical metapopulation processes, including: 1) genetic exchange across populations within an ESU over a long time frame; 2) the opportunity for neighboring populations to serve as source areas in the event of local population extirpations; 3) populations distributed within an ESU so that they are not all susceptible to a specific localized catastrophic event. In addition, the presence of viable populations across MPGs would preserve a high level of diversity, promoting long-term evolutionary potential for adaptation to changing conditions (ICTRT 2007a; see also Section 2.5 of this plan, which explains the VSP parameters).

3.1.2 MPG-Level Viability Criteria

The ICTRT recommended MPG-level viability criteria that take into account the level of risk associated with the MPG's component populations (Figure 3-1). While individual populations meeting viability criteria are expected to have low risk of extinction, the MPG-level criteria ensure robust functioning of the metapopulation and provide resilience in case of catastrophic loss of one or more populations. MPG viability depends on the number, spatial arrangement, and diversity associated with its component populations. The ICTRT developed the following MPG-level criteria considering relatively simple and generalized assumptions about movement or exchange rates among individual populations. In developing these criteria, the ICTRT assumed that catastrophes do not increase dramatically in frequency, that populations are not lost permanently (because of catastrophe or anthropogenic impacts), and that permanent reductions in productivity, including long-term, gradual reductions in productivity, do not occur (ICTRT 2005).

[20] The Middle Columbia steelhead DPS has four extant and no extirpated MPGs. The three extirpated populations are addressed as part of the MPG-level criteria.

MPG-Level Viability Criteria
(ICTRT 2007a)

The following five criteria should be met for an MPG to be regarded as at low risk (viable):

1. At least one-half of the populations historically within the MPG (with a minimum of two populations) should meet viability standards.

2. At least one population should be classified as "Highly Viable."

3. Viable populations within an MPG should include some populations classified (based on historical intrinsic potential) as "Very Large," "Large," or "Intermediate," generally reflecting the proportions historically present within the MPG. In particular, Very Large and Large populations should be at or above their composite historical fraction within each MPG.

4. All major life history strategies (e.g. spring and summer-run timing) that were present historically within the MPG should be represented in populations meeting viability requirements.

5. Remaining MPG populations should be maintained with sufficient abundance, productivity, spatial structure, and diversity to provide for ecological functions and to preserve options for ESU/DPS recovery.

Figure 3-1. Major Population Group Viability Criteria (ICTRT 2007a)

The DPS criterion requiring viable populations in each of the extant MPGs would result in sustainable production across a substantial range of environmental conditions. The presence of viable populations across MPGs would preserve a high level of diversity within the ESU/DPS, thereby promoting long-term evolutionary potential for adaptation to changing conditions. The presence of multiple, relatively nearby, viable and maintained populations acts as protection against long-term impacts of localized catastrophic loss by serving as a source of re-colonization. This criterion is also consistent with recommendations for other ESUs in the Pacific Northwest (e.g., McElhany et al. 2006, PSTRT, 2002). (ICTRT 2007a)

3.1.3 Population-Level Viability Criteria

To be determined to be viable, populations should meet criteria for all four VSP parameters (abundance, productivity, spatial structure, and diversity).

Abundance and productivity

The ICTRT defined abundance and productivity criteria for Middle Columbia steelhead populations (ICTRT 2005 and 2007) based on analyses of the intrinsic potential of the historically available habitat, the locations and sizes of major and minor spawning areas, and, within these areas, the abundance and productivity relationships that would result in a probability of low risk of extinction within 100 years (see Table 2-2 in previous chapter). The abundance "thresholds" shown in the table represent the number of spawners needed for a population of the given size category to achieve the 5 percent (low) risk level at a given productivity. Abundance thresholds are 500, 1000, 1500, and 2250 for population sizes of Basic, Intermediate, Large, and Very Large, respectively, with productivity of 1.56, 1.35, 1.26, and 1.19, respectively.

Spatial structure and diversity

Spatial structure and diversity criteria are more complex. The ICTRT cautions that there is a good deal of uncertainty in assessing the status of spatial structure and diversity in a population. These criteria are based on a set of biological goals and the mechanisms that achieve those goals (see Section 2.4.2, above), and are specific to each population.

3.2 Recovery Scenarios

Populations within the DPS are the units whose risk levels collectively determine MPG viability and the likely persistence of the DPS. The ICTRT recommended that all MPGs in an ESU/DPS should be viable before the ESU/DPS can be considered at low risk of extinction. However, it may not be necessary for all of the populations to attain low risk in order to provide sufficient viability for the DPS; the DPS-level viability criteria allow for some combination of risk status among the component populations. In other words, there is more than one way for an ESU/DPS to meet the viability criteria. The possible combinations of risk status for populations in each MPG that would allow the DPS to meet the viability criteria are called "recovery scenarios."

The ICTRT offered a detailed discussion of possible recovery scenarios for each MPG that would allow the DPS to meet the criteria (ICTRT 2007a). The ICTRT selected these combinations of risk status based on the populations' unique characteristics, such as run timing, population size, or genetics; major production areas in the MPG; and spatial distribution of the populations. Although the ICTRT criteria provide that at least one population in each MPG should reach Highly Viable status, the team did not indicate which population that should be, because of the uncertainties of any population's response to recovery efforts. The ICTRT cautioned against closing off the options for any population prematurely.

> Importantly, although not all populations in an MPG need to meet TRT viability criteria under most viable-MPG scenarios, it is strongly advisable to attempt to improve the status of more than the minimum number of populations to a low risk (viable) situation. There are two primary reasons for this: First, based on current population dynamic theory, the TRT has recommended that all extant populations be maintained with sufficient productivity that the overall MPG productivity does not fall below replacement (i.e. these areas should not serve as significant population sinks). Thus, it would be highly risky to allow the status of any population to degrade. In fact, many populations will need to be improved from their current status to be regarded as "maintained."
>
> Second, although the possible population sets suggested in [the ICTRT's] memo would meet TRT viability criteria for the ESUs, achieving recovery will likely require attempting recovery in more than just those populations because of the uncertainty of success of recovery efforts. A low risk strategy will thus target more populations than the minimum for viability (ICTRT 2007a).

Figure 3.2 shows how the ICTRT applied their MPG-level criteria to the 17 extant populations of the Middle Columbia River Steelhead DPS.

Figure 3-2. Application of ICTRT MPG Viability Criteria to Middle Columbia River Steelhead DPS Recovery Planning: Options for Viability for 4 MPGs

• **MPG & Populations**	• **Size Category**	• **Adult Life History Type**	• **Options**	• **MPG Viability Criteria** • At least one-half the population historically present (minimum of 2 populations) should meet viability standards. • One population should be categorized as highly viable. • Viable populations within an MPG should include some populations classified as 'Very Large", or "Large", and "Intermediate," reflecting proportions historically present. • All major life history strategies historically present should be represented • Remaining MPG populations should be maintained with sufficient abundance, productivity, spatial structure and diversity to provide for ecological functions and to preserve options for DPS recovery.
• **Cascades Eastern Slope MPG:** Applying ICTRT viability criteria, for this MPG to be viable, four populations should meet viability criteria, and one should be highly viable.				• **Considerations**
• Klickitat River	• Intermediate	• Summer/Winter	• Need for Viable status	• Only summer/winter population in MPG, and is Intermediate
• Fifteenmile Creek	• Basic	• Winter	• Need for Viable status	• Only winter population in MPG
• Deschutes River East	• Intermediate	• Summer	• Need for Viable status	• Only Intermediate summer population
• Deschutes River West	• Large	• Summer	• Need for Viable status	• Only extant Large population
• Rock Creek	• Basic	• Summer	• Maintain	• Remaining population
• White Salmon (functionally extirpated)	• Basic	• Summer/Winter	•	• Functionally extirpated, blocked by a dam, abundant hatchery releases of Skamania stock
• Crooked River (extirpated)	• Very Large	• Summer		
• **John Day MPG:** Applying ICTRT viability criteria, for this MPG to be viable, three populations should meet viability criteria, and one should be highly viable.				• **Consideratons**
• Lower Mainstem John Day	• Very Large	• Summer	• Need for Viable	• Only Very Large population – important for spatial

			status	structure because is the most downstream population
• N. Fork John Day	• Large	• Summer	• Need for Viable status	• Only Large population – good candidate for highly viable because now at low risk. Also important to protect.
• Middle Fork John Day	• Intermediate	• Summer	• Option	• Need one Intermediate population
• Upper Mainstem John Day	• Intermediate	• Summer	• Option	• Need one Intermediate population
• So. Fork John Day	• Basic	• Summer	• Maintain	• Remaining population
• **Yakima River MPG:** Applying ICTRT viability criteria, for this MPG to be viable, two populations should meet viability criteria, and one should be highly viable. In this case, the two viable populations could be BOTH Naches R. and Yakima Upper Mainstem, OR one of these and Satus Creek.				• **Consideratons**
• Satus Creek	• Intermediate	• Summer	• Option	• Only Intermediate population
• Naches River	• Large	• Summer	• Option	• Need one of two Large populations and one Intermediate OR both Large populations.
• Yakima Upper Main	• Large	• Summer	• Option	• Need one of two Large populations and one Intermediate OR both Large populations. – This one would be good for spatial structure because it is at the upper end of drainage.
• Toppenish Creek	• Basic	• Summer	• Maintain	• Remaining population
• **Umatilla/Walla Walla MPG:** Applying ICTRT viability criteria, for this MPG to be viable, two populations should meet viability criteria, and one should be highly viable.				
• Umatilla River	• Large	• Summer	• Need for Viable status	• Only Large population
• Walla Walla River	• Intermediate	• Summer	• Option	• Need one of two Intermediate populations – Walla Walla is now closer to meeting criteria than Touchet
• Touchet River	• Intermediate	• Summer	• Option	• Need one of two Intermediate populations
• Willow Creek (extirpated)	• Intermediate	• Summer	•	

3.3 Recovery Goals and Viability Criteria Adopted by Management Unit Plans

The management unit plans include locally determined recovery goals as well as viability criteria for the individual steelhead populations and MPGs in each management unit. Most of the plans also provide targets or objectives to measure progress within specified time frames, e.g. 10 to 50 years.

3.3.1 Oregon Steelhead Recovery Plan (Appendix A)

The Oregon Steelhead Recovery Plan for the Oregon portion of the Middle Columbia steelhead DPS states that the plan's primary goal is to support removal of the Middle Columbia Steelhead DPS from the threatened and endangered species list, and that this would require the Middle Columbia steelhead populations and MPGs in Oregon to reach the levels of biological viability defined by the ICTRT (ODFW 2007, Executive Summary, pp. 1-11-1-12).

3.3.1.1 Broad Sense Recovery Goal

The Oregon Steelhead Recovery Plan adds that a further goal, developed in collaboration with the Middle Columbia Sounding Board (described above in Section 1.6.1), is "to rebuild Oregon's Mid-C steelhead populations to levels that will provide for sustainable fisheries and other ecological, cultural, and social benefits . . . [incorporating] many of the traditional uses, as well as rural and Native American values, deemed important in the Pacific Northwest. . . . Recovery of Middle Columbia steelhead populations will require actions that preserve, enhance and restore healthy watershed conditions where ecosystem functions, processes and dynamics are intact ─ including instream conditions, riparian habitat diversity and complexity, and upland watershed health in concert with complementary management of harvest, hatcheries and hydropower. Recovery is a process that leads to steelhead populations that are not only viable, but that also provide a harvestable surplus for the treaty tribes and for all other citizens of the region" (ODFW 2007, p. 5-17).

3.3.1.2 Recovery Objectives

The Oregon Steelhead Recovery Plan further states the following recovery objectives, to be achieved by the year 2050[21]:

1. Middle Columbia steelhead are viable throughout the historic range and no longer need protection under the ESA;
2. All currently extant Middle Columbia steelhead populations are highly viable;
3. Extirpated populations (e.g. Willow Creek, Crooked River) are restored in a manner that engages landowner cooperation and does not subject landowners to ESA regulation based on the presence of previously extirpated populations until the introduced populations are self-sustaining and become part of the listed DPS;
4. All extant populations of Middle Columbia steelhead are capable of contributing ecological, social, cultural, and economic benefits on a regular and sustainable basis;
5. Working in concert with existing agreements and collaboratively with landowners and resource managers NOAA will define a suite of additional land and water resource

[21] NMFS notes that these objectives are provided by the Oregon Steelhead Recovery Plan and NMFS is not, by providing them here, committing to their implementation.

management principles and practices that when followed will alleviate liability for possible ESA regulatory consequences to landowners and resource managers;
6. Out-of-basin limiting factors are addressed equitably and in concert with in-basin limiting factors;
7. Landowners, land managers and agencies are provided with guidance on the protection and management of habitats to promote the recovery of Middle Columbia River steelhead; and,
8. Land and resource managers work with communities and other interests in a coordinated manner to achieve broad sense recovery through a shared vision of conservation where options and choices are preserved for future generations.

3.3.1.3 Viability Criteria

The Oregon Steelhead Recovery Plan adopts the ICTRT viability criteria for measuring progress toward delisting in terms of the four VSP parameters. Table 3-1 (Table 1-1 in Oregon Steelhead Recovery Plan Executive Summary) shows the minimum threshold abundance levels and minimum productivity required for Oregon Middle Columbia steelhead populations to achieve a 95 percent probability of persistence over 100 years.

Table 3-1. Oregon Mid-C steelhead population characteristics and minimum abundance and productivity values (at the threshold abundance level) needed to achieve a 95 percent probability of persistence over 100 years.

Population	Extant/ Extinct	Life History	Size	Threshold Abundance	Minimum Productivity
Fifteenmile Creek	Extant	Winter	Basic	500	1.56
Deschutes River E.	Extant	Summer	Intermediate	1,000	1.35
Deschutes River W.	Extant	Summer	Large (Inter.)[22]	1,500 (1,000)	1.35
Deschutes/Crooked	Extinct	Summer	Very Large	2,250	1.19
Lower Mainstem John Day R.	Extant	Summer	Very Large	2,250	1.19
North Fork John Day R.	Extant	Summer	Large	1,500	1.26
Middle Fork John Day R.	Extant	Summer	Intermediate	1,000	1.35
South Fork John Day R.	Extant	Summer	Basic	500	1.56
Upper Mainstem John Day R.	Extant	Summer	Intermediate	1,000	1.19
Willow Creek	Extinct	Summer	Intermediate	1,000	1.35
Umatilla River	Extant	Summer	Large	1,500	1.26
Walla Walla River	Extant	Summer	Intermediate	1,000	1.35

3.3.1.4 Recovery Scenario

The Oregon Steelhead Recovery Plan sets a higher standard for Oregon populations than the minimum identified by the ICTRT for DPS viability. Several scenarios or combinations of populations would satisfy the MPG-level viability criteria for the three MPGs containing Oregon Middle Columbia steelhead populations. But the Oregon Steelhead Recovery Plan states that "targeting only the minimum number of populations would likely result in failure to achieve our goals," because of the uncertainty involved in predicting the biological response to management actions intended to aid recovery. "To hedge against this uncertainty, more than the minimum number of populations must be targeted for viable status. Therefore, we also seek to improve

[22] Large size category is for historically accessible area; intermediate size category is for currently accessible area.

other extant Oregon populations to be maintained at sufficient levels to provide for ecological functions and to preserve options for DPS recovery" (Executive Summary p.28).

The following are the Oregon Steelhead Recovery Plan's delisting recommendations[23] for the three MPGs with Middle Columbia steelhead populations in Oregon:

Cascades Eastern Slope Tributaries MPG
To achieve viable status for this MPG, the Fifteenmile Creek, Deschutes River Eastside, Deschutes River Westside, and Klickitat populations must all achieve viable status. One of these populations must be highly viable. The Rock Creek population must be maintained.

John Day River MPG
To achieve viable status for this MPG, the Lower Mainstem John Day River, North Fork John Day River, and either the Middle Fork John Day River or Upper Mainstem John Day River populations must achieve viable status. One of these populations must be highly viable. The South Fork John Day River population must be maintained.

Umatilla/Walla Walla River MPG
To achieve viable status for this MPG, the Umatilla River population and either the Walla Walla River or Touchet River population must achieve viable status. One of these populations must be highly viable. All remaining extant populations must be maintained.

3.3.2 Yakima Steelhead Recovery Plan (Appendix E)

The Yakima Steelhead Recovery Plan was submitted to NMFS by the YBFWRB to address recovery issues for the Yakima MPG of Middle Columbia steelhead (see Section 1.5.2). This plan states that its "overall goal . . . is to ensure long-term persistence of viable populations of naturally produced steelhead distributed across their native range."

3.3.2.1 Broad Sense Recovery Goal

The Yakima Steelhead Recovery Plan sets a long-term, or broad sense, recovery goal to increase the abundance and productivity of Yakima Basin steelhead populations to levels that allow for harvest for recreational, commercial, and ceremonial purposes. This goal is articulated in the YBFWRB's Vision 2020 statement (Section 1.2 of the Yakima Steelhead Recovery Plan), which describes, in general terms, desired future conditions for the Yakima basin:

> *Yakima River basin communities have restored the Yakima River basin sufficiently to support self-sustaining and harvestable populations of indigenous fish and wildlife while enhancing the existing customs, cultures, and economies in the basin. Decisions that continuously improve the river basin ecosystem are made in an open and cooperative process that respects different points of view and varied statutory responsibilities and benefits current and future generations.*

[23] The delisting decision is NMFS' responsibility, as described in Section 3.5.

3.3.2.2 Recovery Objectives/Scenarios

The Yakima Steelhead Recovery Plan defines three "thresholds" for assessing progress toward recovery: thresholds for ESA delisting, short-term recovery, and long-term (broad sense) recovery. As used in the Yakima Steelhead Recovery Plan, "threshold" combines two concepts that are differentiated in this DPS plan, i.e. recovery objectives and recovery scenario. The YBFWRB sees these three thresholds as points on a continuum and expects recovery actions to continue after delisting, even without the immediate motivation of the ESA. The long-term goals are less definite, but are meant to affirm that the Board and its partners believe that long-term recovery to significantly higher abundance levels is both feasible and desirable.

The delisting threshold is based on the ICTRT's MPG viability criteria: one population should be viable, one highly viable, and two should be at "maintained" status or better. The YBFWRB expected that the Satus population would be most likely to achieve "highly viable" status, the Naches population "viable," and the Toppenish and Upper Yakima populations "maintained."

The short-term recovery threshold also is based on the ICTRT criteria, but with continuing recovery actions, all four populations would be expected to achieve viable status. This would significantly reduce overall risk to the MPG.

The long-term recovery threshold is, as described above, a stable, long-term condition in which wild steelhead in the Yakima Basin are thriving and harvestable, based on restored access to as many of the historically accessible stream reaches as is consistent with the Board's commitment to sustaining local customs and economies.

3.3.2.3 Viability Criteria

The Yakima Steelhead Recovery Plan defines abundance and productivity criteria for the delisting, short-term, and long-term thresholds in terms of the ICTRT's viability criteria, as shown in Table 3-1.

Table 3-2 Yakima Steelhead Populations Abundance and Productivity Criteria (Source: Executive Summary, Yakima Steelhead Recovery Plan)

	Delisting Threshold		Short-Term Recovery		Long-term Recovery	
Population	**Avg. #**	**Prod.**	**Avg. #**	**Prod.**	**Avg. #**	**Prod.**
Satus: Satus Watershed[24] Mainstem Block	 500 500	 2.00[25] 1.65	 500 500	 1.56 1.56	2,000	 1.2 1.2
Toppenish	250	1.2	500	1.56	1,500	1.2
Naches	1,500	1.26	1,500	1.26	5,400	1.2
Upper Yakima	500	1.2	1,500	1.26	7,700	1.2
Total	***3,250***		***4,500***		***16,600***	

The Yakima Steelhead Recovery Plan presents spatial structure and diversity criteria for the four Yakima steelhead populations. The spatial structure criteria are more complex, since several important historical spawning areas are either no longer accessible to steelhead or no longer feasible for spawning.

Satus
Naturally produced steelhead will occupy both major spawning areas in the Satus watershed (Satus and Dry Creek MSAs) and the Mule Dry minor spawning areas. Consistent spawning must occur in both major spawning areas.

Toppenish
Naturally produced steelhead will occupy both of the major spawning areas in the Toppenish watershed (upper Toppenish and Simcoe). Consistent spawning must occur in both major spawning areas.

Naches
Naturally produced steelhead will occupy at least seven of the eight major spawning areas for the delisting and short-term recovery thresholds. For the long-term recovery threshold, all eight will be occupied. Consistent spawning must occur within the Naches mainstem, Ahtanum Creek, and Rattlesnake Creek to maintain distribution across habitat types and life histories.

[24] For its historical population analysis, the ICTRT included the mainstem Yakima habitat below the confluence of Satus Creek in the Satus Creek population, and therefore classified the Satus population as Intermediate in size. However, if the potential mainstem component is lumped instead with mainstem Yakima River habitat upstream of Satus, the population in the Satus Creek watershed alone would be Basic size. The Yakima plan discusses this question in more detail.
[25] The Yakima Steelhead Recovery Plan calls for managing the Satus population in two blocks: the tributary block treated as a Basic population with the goal of high viability and the mainstem block treated with a simple abundance target that can be met within that portion of the mainstem Yakima or by additional production above and beyond the abundance targets for other areas.

Upper Yakima
Naturally produced steelhead will occupy at least 10 of the 14 major spawning areas for the delisting and short-term recovery thresholds. For the long-term recovery threshold, 12 of 14 MSAs will be occupied. Spawning must consistently occur within at least the Yakima mainstem, Umtanum Creek, Swauk Creek, Manashtash Creek, Taneum Creek and the Teanaway River (West and North Teanaway MSA and Lower Teanaway minor spawning area). While passage at Cle Elum, Kachess and/or Keechelus Dams is not specifically required to meet this threshold, providing passage can play an important role.

The diversity goal for all thresholds is to maintain and enhance both phenotypic (morphology, behavior, and life history traits) and genotypic diversity while limiting introgression of non-local genes.

3.3.3 Washington Gorge Management Unit Plans (Appendices B, C, and D)

The Klickitat River Plan's primary goal is to restore the Klikitat steelhead population to viable status and thus to support recovery of the Middle Columbia steelhead DPS (Appendix B). The Rock Creek Plan's primary goal is to achieve "maintained" status for the Rock Creek population as part of attaining viable status for the Cascades Eastern Slope Tributaries MPG (Appendix C). The White Salmon Plan's goal is to re-establish the White Salmon River population so that it can contribute to the conservation and survival of the DPS.

3.3.3.1 Broad Sense Recovery Goal

If a Washington Gorge Area regional recovery planning organization is created, it would have the option of developing broad sense goals for the area in a collaborative process with diverse stakeholders.

In the meantime, the Yakama Nation has proposed, as a broad sense goal for the Klickitat steelhead population, the achievement of "highly viable" status, which corresponds to a one percent risk of extinction in a 100-year period. Achieving highly viable status for the population would provide for long-term, sustainable harvest and other social, cultural, and ceremonial needs, although it would likely exceed the minimum necessary to support delisting the DPS.

3.3.3.2 Recovery Objectives

At this time NMFS is simply providing proposed ICTRT viability criteria for the Klickitat and Rock Creek populations.

3.3.3.3 Viability Criteria

The Klickitat and Rock Creek plans adopt the ICTRT viability criteria for their respective populations. The White Salmon plan advocates recovering the White Salmon extirpated population to viable status when passage is restored.

<u>Klickitat Subbasin Recovery Plan (Appendix B)</u>: The ICTRT-recommended minimum abundance threshold for the Klickitat steelhead population to meet the criterion of a 5 percent or less risk of extinction over a 100-year time frame is 1000 naturally produced spawners at 1.3 spawner/spawner ratio. Regarding spatial structure and diversity, the Plan recommends research

on the extent of the impacts of an outside stock (i.e. Skamania stock) hatchery program on natural spawning areas in the subbasin, and reducing these impacts if they are found to be substantial.

Rock Creek Subbasin Recovery Plan (Appendix C): The ICTRT-recommended minimum abundance threshold for the Rock Creek steelhead population to meet the criterion of a 5 percent or less risk of extinction over a 100-year timeframe is 500 naturally produced spawners. The current steelhead range in the Rock Creek watershed is believed to generally resemble the historical condition; therefore, the plan recommends maintaining current spatial structure.

White Salmon Subbasin Recovery Plan (Appendix D): The White Salmon steelhead population was functionally extirpated by the construction of Condit Dam. The dam is scheduled to be removed, beginning in 2009. The ICTRT recognizes that recovering this functionally extirpated population to a viable level may not be necessary to achieve viability at the MPG and DPS levels (ICTRT 2007a). When the dam is removed, the Plan recommends that this population eventually be recovered to a minimum abundance threshold of 500 spawners.

3.3.3.4 Recovery Scenario

The Klickitat and Rock Creek plans adopt the ICTRT-recommended scenario for their respective populations, i.e. to achieve viable status for the Klickitat population and maintained status for Rock Creek. The White Salmon plan advocates recovering the White Salmon extirpated population to viable status when passage is restored.

3.3.4 Snake River Salmon Recovery Plan for Southeast Washington (Appendix F)

The Snake River Salmon Recovery Board (SRSRB) "defined salmon recovery at two levels: recovery and restoration. Recovery is defined as meeting ESA de-listing requirements based on VSP criteria. The goal of restoration is attainment of conditions that provide increased harvest opportunity for local communities and Tribes, thereby meeting [tribal] trust and treaty rights, as well as fisheries mitigation objectives for mainstem dams."

3.3.4.1 Broad Sense Goal

For the SE Washington plan, the equivalent of the broad sense goal is what this plan calls "restoration." Restoration means not simply harvestable levels of steelhead but also "a healthy ecosystem that fulfills the requirements of the key species and the people of the recovery region . . . [with] adequate and appropriate habitat for all salmonid life stages and free access to that habitat." Harvest must be at sustainable levels, hatcheries must contribute to recovery with minimal risk, and hydrosystems must not jeopardize the continued existence of the species.

The plan summarized restoration goals for abundance that were proposed by various agencies and Tribes, which include both naturally produced and hatchery returns (see Table 5-12, SRSRB Plan). Fisheries co-managers and the SRSRB are currently still in discussion regarding these longer-term goals.

3.3.4.2 Recovery Objectives – Planning Targets

The SRSRB set "short-term" (15-year) recovery planning targets for the Walla Walla and Touchet populations of the Walla Walla/Umatilla MPG, based on the ICTRT's viability curves for those populations. Both populations are classified as Intermediate size, and therefore their recovery goal is 1000 spawners each, with 1.35 spawner:spawner ratio.

The management unit plan also established general planning targets for spatial structure and diversity, as follows:

1. Where possible, expand current spawning distributions to match the historic condition as defined by the Major Spawning Areas in each subbasin.
2. Develop populations that are separated spatially so that risks due to catastrophic events are reduced.
3. Increase, insofar as the historical patterns can be reconstructed, the similarity between current and historical patterns of juvenile rearing distribution, habitat usage, and life history types.

The SRSRB plan also sets specific targets for habitat improvements, including criteria for such factors as large woody debris, riparian condition, water temperature, and channel confinement (Chapter 7, SRSRB Plan).

3.3.4.3 Viability Criteria

The SRSRB Plan used the ICTRT viability curves for each population to determine abundance and productivity values needed for delisting and also to identify the values needed for restoration of the populations under improved habitat conditions.

3.3.4.4 Recovery Scenario

The Southeast Washington Plan accepts the ICTRT recovery criteria and thus supports the scenario shown in Figure 3-1, which indicates that either the Walla Walla or Touchet Middle Columbia steelhead population should reach viable status for delisting. However, the SRSRB's long-term restoration goal is to achieve a healthy ecosystem that supports viability for both steelhead populations.

3.4 Threats Criteria

Listing factors (or threats) are those features that are evaluated under section 4(a)(1) when initial determinations are made whether to list species for protection under the ESA. Listing factors initially identified may or may not still be limiting recovery in the future when NMFS reevaluates the status of the species to determine whether the protections of the ESA are no longer warranted and the species could be delisted.

ESA section 4(a)(1) listing factors are the following:

A. Present or threatened destruction, modification, or curtailment of [the species'] habitat or range;
B. Over-utilization for commercial, recreational, scientific, or educational purposes;
C. Disease or predation;

D. Inadequacy of existing regulatory mechanisms; or
E. Other natural or human-made factors affecting [the species'] continued existence.

At the time of a delisting decision for the Middle Columbia steelhead, NMFS will examine whether the section 4(a)(1) listing factors have been addressed. To assist in this examination, NMFS will use the listing factors (or threats) criteria described below, in addition to evaluation of biological recovery criteria and other relevant data and policy considerations. The threats need to have been addressed to the point that delisting is not likely to result in their re-emergence. It is possible that currently perceived threats will become insignificant in the future due to changes in the natural environment or changes in the way threats affect the entire life cycle of salmon. Consequently, NMFS expects that the relative priority of threats will change over time and that new threats may be identified. During the status reviews, NMFS will evaluate and review the listing factor criteria as they apply at that time.

The specific criteria listed below for each of the relevant listing/delisting factors help to ensure that underlying causes of decline have been addressed and mitigated before a species is considered for delisting. NMFS expects that if the proposed actions described in the Plan are implemented, they will make substantial progress toward meeting the following listing factor (threats) criteria for the Middle Columbia steelhead.

Factor A: The present or threatened destruction, modification, or curtailment of its habitat or range

To determine that the DPS is recovered, threats to habitat should be addressed as outlined below:

1. Passage obstructions (e.g., dams and culverts) are removed or modified to improve survival and restore access to historically accessible habitat where necessary to support recovery goals.

2. Flow conditions that support adequate rearing, spawning, and migration are achieved through management of mainstem and tributary irrigation and hydropower operations, and through increased efficiency and conservation in other consumptive water uses such as municipal supply.
3. Sufficient instream flows are protected to provide for steelhead in appropriate life stages.

4. Forest management practices that protect watershed and stream functions are implemented on Federal, state, tribal, and private lands.

5. Agricultural practices, including grazing, are managed in a manner that protects and restores riparian areas, floodplains, and stream channels, and protects water quality from sediment, pesticide, herbicide, and fertilizer runoff.

6. Urban and rural development, including land use conversion from agriculture and forestland to residential uses, does not reduce water quality or quantity, or impair natural stream conditions so as to impede achieving recovery goals.

7. The effects of toxic contaminants on salmonid fitness and survival are sufficiently limited so as not to affect recovery.

8. Channel function, including vegetated riparian areas, canopy cover, stream-bank stability, off-channel and side-channel habitats, natural substrate and sediment processes, and channel complexity are restored to provide adequate rearing and spawning habitat.

9. Floodplain function and the availability of floodplain habitats for salmon are restored to a degree sufficient to support a viable DPS. This restoration should include connectedness between river and floodplain and the restoration of impaired sediment delivery processes.

Factor B: Over-utilization for commercial, recreational, scientific or educational purposes

To determine that the DPS is recovered, any utilization for commercial, recreational, scientific, or educational purposes should be managed as outlined below:

1. Fishery management plans for steelhead are in place that (a) accurately account for total fishery mortality (i.e., both landed catch and non-landed mortalities) and constrain mortality rates to levels that are consistent with recovery; and (b) are implemented in such a way as to avoid deleterious genetic effects on populations or negative effects on the distribution of populations.

2. Federal, tribal and state rules and regulations are effectively enforced.

3. Technical tools accurately assess the effects of the harvest regimes so that harvest objectives are met but not exceeded.

4. Handling of fish is minimized to reduce indirect mortalities associated with educational or scientific programs, while recognizing that monitoring, research, and education are key actions for conservation of the species.

5. Routine construction and maintenance practices are managed to reduce or eliminate mortality of listed species.

Factor C: Disease or predation

To determine that the DPS is recovered, any disease or predation that threatens its continued existence should be addressed as outlined below:

1. Hatchery operations do not subject targeted populations to deleterious diseases and parasites and do not result in increased predation rates of wild fish.

2. Predation by avian predators is managed in a way that allows for recovery of salmon and steelhead populations.

3. The northern pikeminnow is managed to reduce predation on the targeted populations.

4. Populations of introduced exotic predators such as smallmouth bass, walleye and catfish are managed such that competition or predation does not impede recovery.

5. Predation of winter steelhead runs below Bonneville Dam by marine mammals does not impede achieving recovery.

6. Physiological stress and physical injury that may cause disease or increase susceptibility to pathogens during rearing or migration is reduced during critical low flow periods (e.g. low water years) or poor passage conditions (e.g. at diversion dams or bypasses).

Factor D: The inadequacy of existing regulatory mechanisms

To determine that the DPS is recovered, any inadequacy of existing regulatory mechanisms that threatens its continued existence should be addressed as outlined below:

1. Adequate resources, priorities, regulatory frameworks, and coordination mechanisms are established and/or maintained for effective enforcement of land and water use regulations that protect and restore habitats, including water quality and water quantity, and for the effective management of fisheries.
2. Habitat conditions and watershed functions are protected through land-use planning that guides human population growth and development.
3. Habitat conditions and watershed function are protected through regulations that govern resource extraction such as timber harvest and gravel mining.
4. Habitat conditions and watershed functions are protected through land protection agreements as appropriate, where existing policy or regulations do not provide adequate protection.
5. Regulatory, control, and education measures to prevent additional exotic plant and animal species invasions are in place.
6. Sufficient priority instream water rights for fish habitat are in place.

Factor E: Other natural or human-made factors affecting [the species'] continued existence

To determine that the DPS is recovered, other natural and man-made threats to its continued existence should be addressed as outlined below:

1. Hatchery programs are being operated in a manner that is consistent with individual watershed and region-wide recovery approaches; appropriate criteria must be used for the integration of hatchery steelhead populations and extant natural populations inhabiting watersheds where the hatchery fish return.
2. Hatcheries operate using appropriate ecological, genetic, and demographic risk containment measures for (1) hatchery-origin adults returning to natural spawning areas, (2) release of hatchery juveniles, (3) handling of natural-origin adults at hatchery facilities, (4) withdrawal of water for hatchery use, (5) discharge of hatchery effluent, and (6) maintenance of fish health during their propagation in the hatchery.
3. Nutrient enrichment programs are implemented where it is determined that nutrient limitations are a significant limiting factor for steelhead production and that nutrient enrichment will not impair water quality.

3.5 Delisting Decision

NMFS concludes that the biological viability criteria as described in Sections 3.1 and 3.2, and the listing factor (threats) criteria (described in Section 3.4), define conditions that, when met, would result in a determination that the Middle Columbia steelhead DPS is not likely to become endangered within the foreseeable future throughout all or a significant portion of its range. These criteria could exceed the minimum necessary to delist the DPS.

In accordance with our responsibilities under section 4(c)(2) of the ESA, NMFS will conduct status reviews of Middle Columbia steelhead once every five years to evaluate the status of the DPS and determine whether it should be removed from the list or changed in status. Such evaluations will take into account the following:

- The biological recovery criteria (ICTRT 2007a) and listing factor (threats) criteria described above.
- The management programs in place to address the threats.
- Principles presented in the Viable Salmonid Populations paper (McElhany et al. 2000).
- Best available information on population and DPS status and new advances in risk evaluation methodologies.
- Other considerations, including: the number and status of extant spawning groups; the status of the major spawning groups; linkages and connectivity among groups; the diversity of life history and phenotypes expressed; and considerations regarding catastrophic risk.

4. CURRENT STATUS ASSESSMENT OF DPS

ICTRT scientists have aggregated a description of current Middle Columbia steelhead DPS status from information on the status of the component populations, using the VSP parameters of abundance, productivity, spatial structure, and diversity. Several related research reports from the ICTRT, including the most recent status assessment, are available on the Northwest Fisheries Science Center website, http://www.nwfsc.noaa.gov/trt/trt_columbia.cfm.

4.1 ICTRT Status Assessment of Middle Columbia Steelhead DPS

The status of a salmonid ESU or DPS is expressed in terms of likelihood of persistence over 100 years, or in terms of risk of extinction within 100 years. The ICTRT defines viability at two levels: less than 5 percent risk of extinction within 100 years (viable) and less than 1 percent risk of extinction within 100 years (highly viable). A third category, "maintained," represents a less than 25 percent risk. The risk level of the DPS is built up from the aggregate risk levels of the populations and MPGs. All four VSP parameters must be taken into account to determine the risk level.

Table 4-1 summarizes current status of the Middle Columbia steelhead populations, showing 10-year geometric mean abundance by population, estimated productivity (using a 20-year geometric mean), and the minimum abundance threshold needed for long-term viability. The table also includes the 10-year geometric mean proportion of hatchery spawners for the populations where data are available, and the risk ratings of high, moderate, low, and very low, for abundance and productivity combined, and spatial structure and diversity combined. In this chapter, two other ways of representing these findings are presented: graphs called "viability curves" showing the relationship of current abundance and productivity to that required for viability, and a matrix combining all four parameters to illustrate the overall risk rating of each population.

4.2 Viability Curves

The ICTRT developed viability criteria expressed as graphs showing the relationship between abundance and productivity. The result is a curve, called a "viability curve," running from high abundance/low productivity to high productivity/low abundance. The ICTRT then developed a method for adapting viability curves to population size categories, which, as described in Section 2.5, are based on estimated intrinsic production potential or capacity of the habitat. The actual current abundance and productivity are then plotted against this viability curve. Populations above the 5 percent risk curve are considered to have a low risk of extinction and below the 5 percent risk curve a higher risk of extinction.

Viability curves for Basic, Intermediate, Large, and Very Large Middle Columbia steelhead populations are depicted below in Figures 4-1 through 4-4, respectively. Only the Deschutes River East and Walla Walla populations (Intermediate) in Figure 4-2 and the North Fork John Day population (Large) in Figure 4-3 meet or exceed the 5 percent minimum risk of extinction in 100 years needed to meet the ICTRT viability criteria. The ovals about the point estimates of actual abundance and productivity represent one standard error of uncertainty about the points.

Table 4-1. Middle Columbia River steelhead DPS populations: summary of abundance, productivity, risk ratings, and minimum abundance thresholds (Source: ICTRT 2007c and 2008). (Numbers subject to periodic updates as additional information becomes available.)

Population	*Abundance Threshold*[26]	*Size Category*	*Run Timing*	*10-year Geomean abundance*	*Abundance Range*	*10-yr Hatchery Fraction*[27]	*Produc-tivity*[28]	*Productivity Standard Error*	*A&P Risk*[29] *Rating*	*SSD Risk Rating*
Eastern Cascades MPG										
Deschutes (westside)	1000[30]	Large (Inter)	Summer	456	108-1283	0.26	1.05	0.15	H	M
Deschutes (eastside)	1000	Intermed.	Summer	1599	299-8274	0.39	1.89	0.27	L	M
Klickitat River	1000	Intermed.	Wtr & Smr						M	M
Fifteenmile Creek	500	Basic	Winter	703	231-1922	0	1.82	0.20	L	L
Rock Creek	500	Basic	Summer	Insufficient Data					H	M
White Salmon	500	Basic		Functionally extirpated					N/A	N/A
Crooked River	2250	Very Large	Summer	Extirpated						
Yakima River MPG										
Upper Yakima River	1500	Large	Summer	85	34-283	0.02	1.12	0.22	H	H
Naches River	1500	Large	Summer	472	142-1454	0.06	1.12	0.22	H	M
Toppenish River	500	Basic	Summer	322	44-1252	0.06	1.60	0.30	M	M
Satus Creek (trib only)	1000	Intermed.	Summer	379	138-1000	0.06	1.73	0.14	M	M
John Day River MPG										
Lower Mainstem John Day	2250	Very Large	Summer	1800	563-6257	0.1	2.99	0.24	M	M
North Fork John Day	1500	Large	Summer	1740	369-10,235	0.08	2.41	0.22	VL	L
Upper Mainstem John Day	1000	Intermed.	Summer	524	185-5169	0.08	2.14	0.33	M	M
Middle Fork John Day	1000	Intermed.	Summer	756	195-3538	0.08	2.45	0.16	M	M
South Fork John Day	500	Basic	Summer	259	76-2729	0.08	2.06	0.27	M	M
Umatilla/Walla Walla MPG										
Umatilla River	1500	Large	Summer	1472	592-3542	0.36	1.50	0.15	M	M
Walla Walla Mainstem	1000	Intermed.	Summer	650	270-1746	0.02	1.34	0.12	M	M
Touchet River	1000	Intermed.	Summer	Insufficient Data					H	M
Willow Creek	1000	Intermed.	Summer	Extirpated					N/A	N/A

[26] Abundance threshold for viability based on habitat intrinsic potential
[27] Average proportion of hatchery spawners over most recent 10 years in the data series.
[28] Geomean return per spawner calculated over most recent 20 years in data series.
[29] H = high risk, M= moderate risk, L = low risk, VL = very low risk
[30] The Deschutes Westside steelhead population is classified as Large in terms of spatial structure, but its abundance threshold may be considered 1000 or 1500 because of "currently accessible area" considerations. See Carmichael, Richard W., Draft Recovery Plan for Oregon's Middle Columbia River Steelhead: Progress Report. January 17, 2006

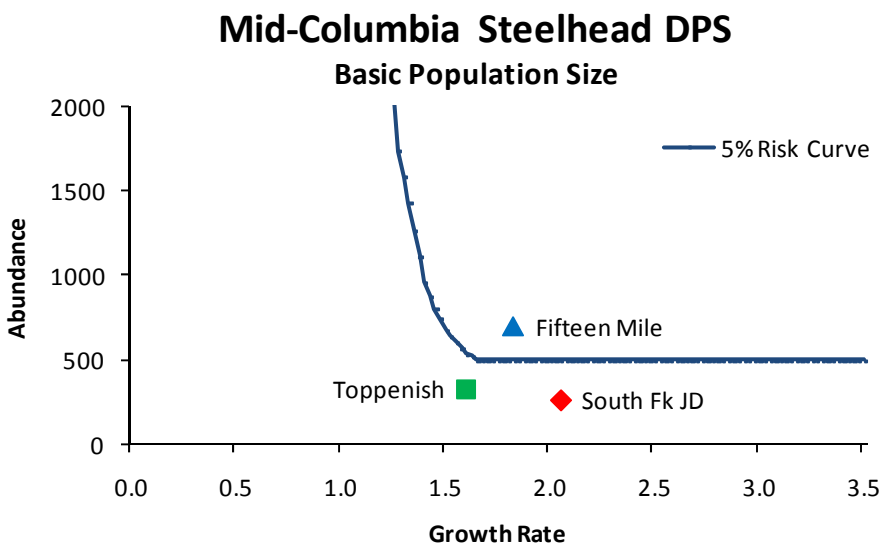


Figure 4-1. Middle Columbia River Steelhead Basic Populations (based on ICTRT 2008).

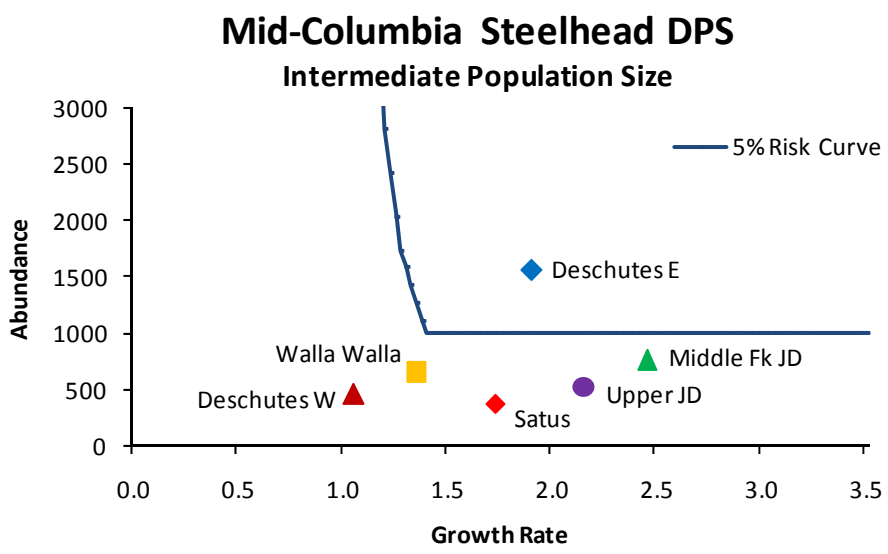


Figure 4-2. Middle Columbia River Steelhead Intermediate Populations (based on ICTRT 2008).
Note: The Deschutes Westside steelhead population is classified as Large in terms of spatial structure, but its abundance threshold may be considered 1000 or 1500 because of "currently accessible area" considerations. See Carmichael, Richard W., Draft Recovery Plan for Oregon's Middle Columbia River Steelhead: Progress Report. January 17, 2006.

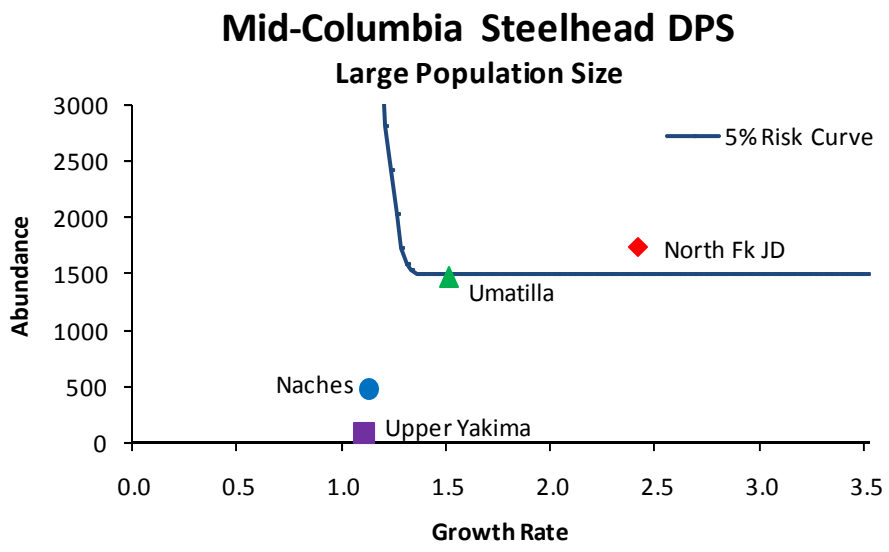


Figure 4-3. Middle Columbia River Steelhead Large Populations (based on ICTRT 2008).

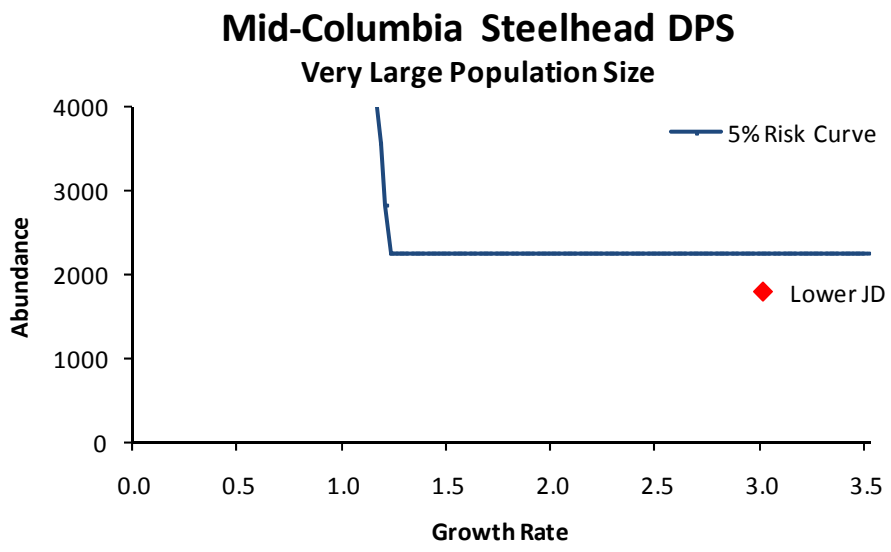


Figure 4-4. Middle Columbia River Steelhead Very Large Populations (based on ICTRT 2008).

4.3 Population-Level Risk Rating

Given the hierarchical structure of salmonid biology (see Section 2.2, above), an overall assessment of risk of extinction for an ESU or DPS must be built up from assessments of risk for the component populations and then the MPGs.

The ICTRT integrated all four VSP parameters in a simple matrix (Figure 4-5). One side of the matrix is a series of risk levels for the combined abundance and productivity parameters (A/P):

very low risk, i.e. less than a 1 percent risk of extinction within 100 years; low risk, less than a 5 percent risk of extinction within 100 years; moderate risk, less than a 25 percent risk of extinction within 100 years; and high risk, more than a 25 percent risk of extinction within 100 years. The A/P rating for each population is taken from the corresponding viability curve (see Section 4.3 above). A viable population is considered to have no more than a 5 percent A/P risk.

Across the top of the matrix is a series of risk levels for spatial structure and diversity (SS/D). The range of viable combinations of A/P and SS/D risks for a population can be seen in the top two rows combined with the first three columns. Populations with a Very Low risk rating for A/P and at least a Low rating for SS/D are considered to be "Highly Viable." Populations with a Low risk rating for A/P and a Moderate rating for SS/D are considered to be "Viable." Populations that fall into the cells outside this range cannot be considered viable by the standard set forth in the VSP paper (McElhany et al., 2000) and used by all of the TRTs. These individual scores are integrated to determine the viability of MPGs (ICTRT 2005), and the assessments of the component MPGs are aggregated to assess the DPS as a whole. The ICTRT used this approach to examine the viability of independent steelhead populations in the Middle Columbia DPS.

In Figure 4-5, five of the cells at higher risk are labeled "Candidate for maintained status." The ICTRT recognizes that some populations may not need to be fully viable to make the DPS viable, and yet maintaining them at some level will provide ecological functions and preserve options for DPS recovery. As a rule of thumb, populations that fall within cells adjacent to those regarded as viable in the risk matrix (Figure 4-5 in this recovery plan) can be regarded as "maintained."

The ICTRT (2007a) details how maintained populations contribute to the ecological functioning of the DPS and preserve recovery options in the event that efforts to recover other populations to viable levels fail.

Having populations meet maintained standards:

- Provides a hedge against the potential risk that the cumulative productivity across populations within an MPG may fall below replacement.
- Provides insurance against catastrophic events. For example, if a catastrophe impacts one or more of the functioning viable populations within the MPG, the other populations will need to be at sufficient levels so that they can replenish those populations lost to or affected by the catastrophe.
- Allows these populations to serve as genetic or demographic "stepping stones" between populations, allowing natural patterns of gene flow and dispersal.
- Provides a buffer against uncertainty in the ICTRT population and MPG criteria. For example, having populations meet maintained standards preserves recovery options in the event that efforts to recover other populations to viable levels fail.

Although populations with specific combinations of A/P and SS/D ratings are candidates for Maintained status (Figure 4-5), the ICTRT cautions that it is difficult to capture all of the necessary attributes to meet the objectives for maintained populations in a simple set of integrated A/P and SS/D risk ratings. For each MPG, candidate populations should be reviewed individually and in context with the other populations against the above principles.

"In general, populations with moderate abundance and productivity risk levels near 25% with high year-to-year variability or populations with high risk for multiple SS/D factors are less likely to be considered Maintained. A primary consideration in setting an abundance objective [for a] population in the smallest size category (Basic) would be uncertainty in current estimates of abundance and productivity. Given the levels of uncertainty in estimating recent geomean abundance and productivity, the abundance objectives for Basic populations should exceed 250 spawners [if they are] to be designated as Maintained status. Populations classified in any of the three largest size categories should be at abundance levels not less than 500, and will likely require average abundance levels approaching minimum threshold values to address demographic and genetic considerations." (ICTRT 2007a)

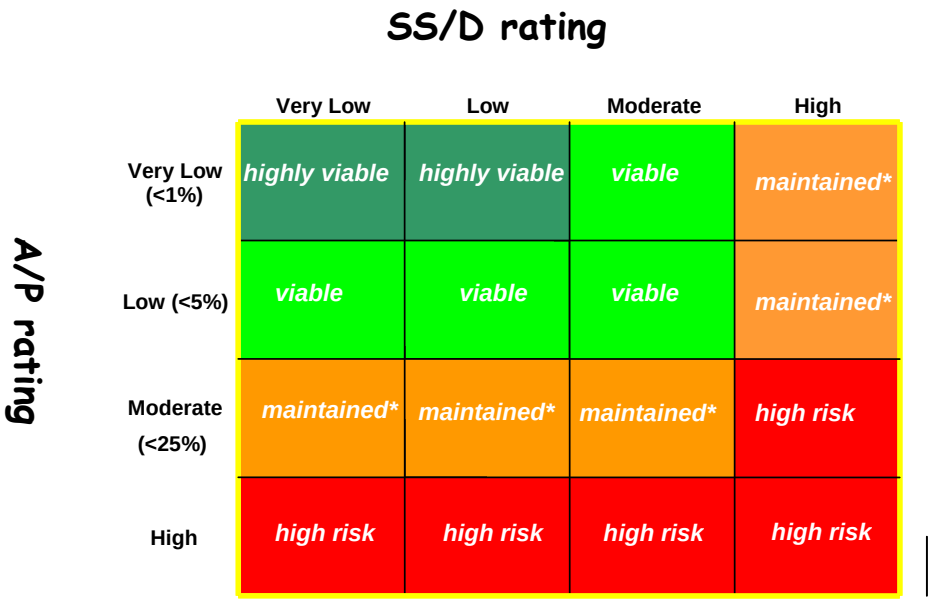


Figure 4-5. Assessing Population Viability Across VSP Criteria (ICTRT 2006).
***** Candidate for maintained status

4.4 Current Population Status

According to the ICTRT viability criteria, the majority of natural Middle Columbia steelhead populations are rated at moderate risk for abundance and productivity, but low to moderate risk for spatial structure and diversity (Table 4-1 and Figure 4-5). This DPS includes one highly viable population (North Fork John Day), two viable (Fifteenmile Creek and Deschutes River Eastside), five at high risk of extinction within 100 years (Deschutes Westside, Upper Yakima Mainstem, Naches River, Rock Creek, and Touchet[31]), and the remaining nine at moderate risk.

[31] The Rock Creek and Touchet populations are rated at High Risk because of uncertainty resulting from the limited set of annual return estimates (with significant missing years) currently available.

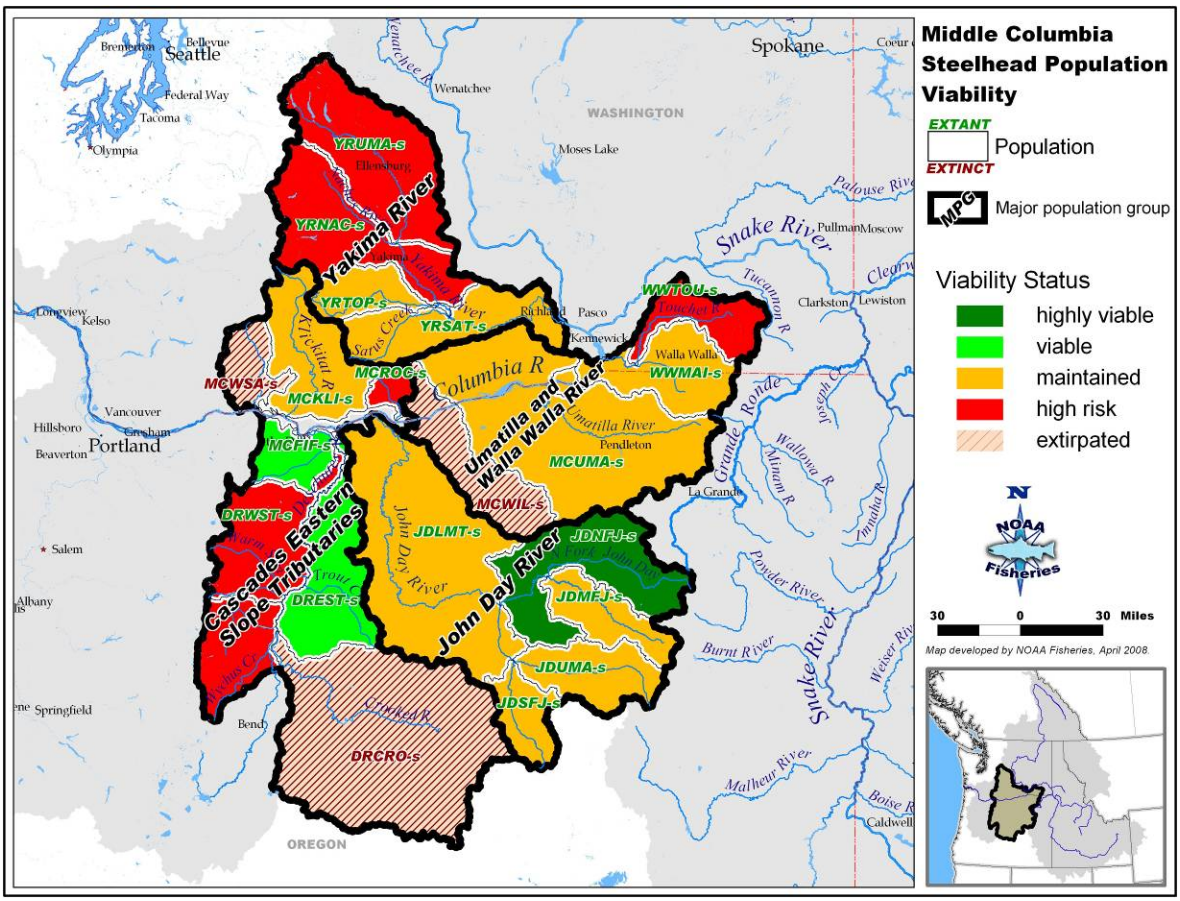


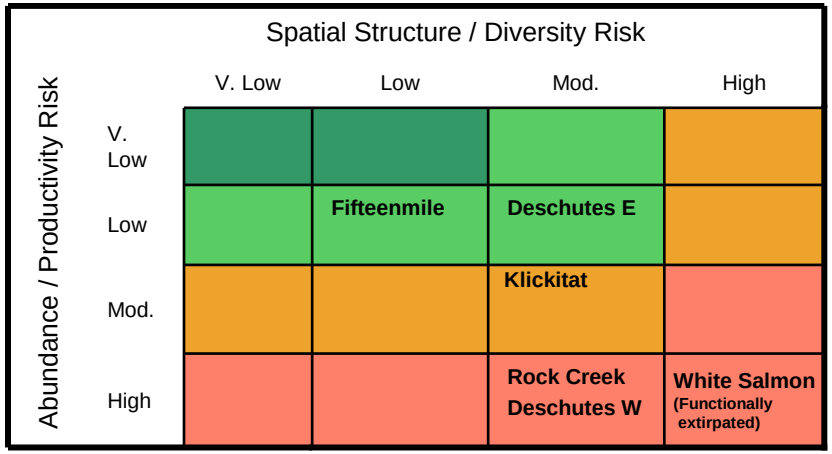
Figure 4-6. Middle Columbia Steelhead Population Viability (ICTRT, May 2008)

4.5 MPG Status

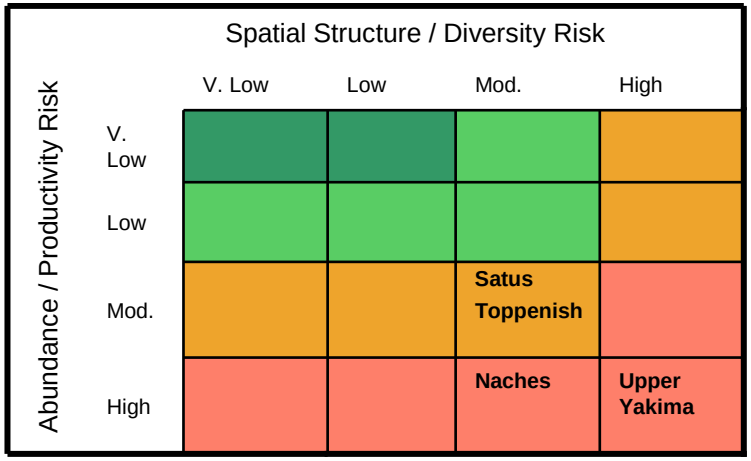
The ICTRT's viability ratings of the component populations of each Middle Columbia steelhead MPG are shown in the matrices below (Figure 4-6). None of the MPGs as a whole reaches low risk status according to the ICTRT's MPG-level criteria (shown in Figure 3-2).

4.6 DPS Status

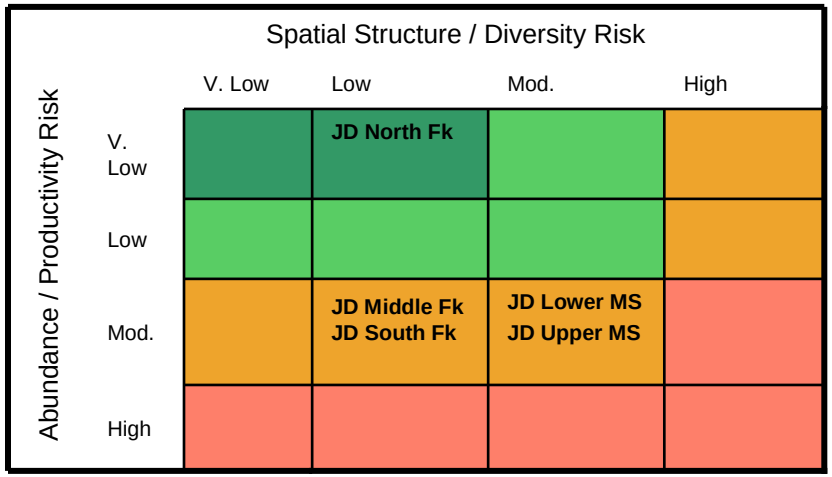
The ICTRT's ESU-level viability criterion is the following: All extant MPGs and any extirpated MPGs critical for proper functioning of the ESU should be at low risk (ICTRT 2007a). Thus, the Middle Columbia steelhead DPS does not currently meet viability criteria based on the determination that the four component MPGs are not at low risk.



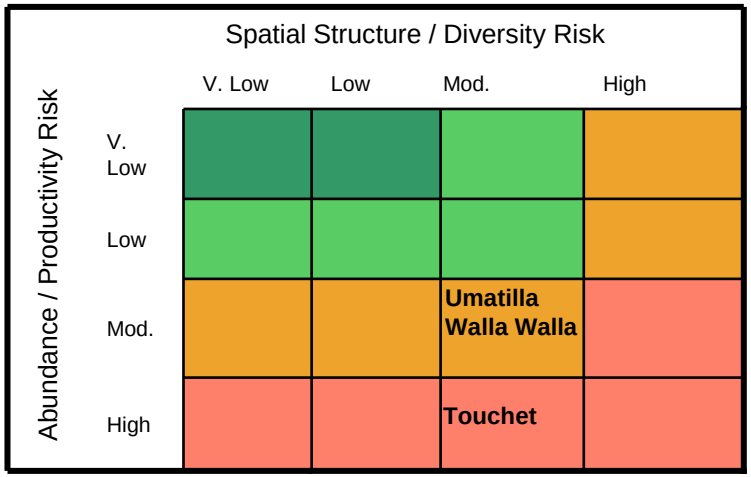
Cascades Eastern Slopes Tributaries Major Population Group.



Yakima River Major Population Group.



John Day River Major Population Group



Umatilla/Walla Walla Major Population Group

Figure 4-7. Viability Ratings for Middle Columbia Steelhead Populations by MPG (developed by NMFS based on *Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs*, review draft, ICTRT 2007a, http://www.nwfsc.noaa.gov/trt/col/trt_viability.cfm)

5. THE 'GAP' BETWEEN CURRENT AND DESIRED STATUS

The ICTRT assessed the difference between a listed species' or population's current status for abundance and productivity and the viability criteria. This difference is called the "gap." The gap, as used in this plan, is a measure, although it is inevitably imprecise, of the improvement in survival needed to meet viability criteria. As such, it is also an indicator of the level of effort needed to achieve recovery. The following material is taken from the ICTRT's "Survival Gaps Report" (ICTRT 2007c) for the listed salmon and steelhead in the Interior Columbia Basin.

Although all four VSP parameters contribute to overall population and DPS viability, the gap is discussed quantitatively only in terms of abundance and productivity. Qualitative statements may be made about needed improvements to spatial structure and diversity, but the metrics—the methods of measurement—used to assess the risk levels of spatial structure and diversity are not easily summed up into a single statistic.

A key part of the "gap" calculation is the productivity of the population. The ICTRT used a measure of productivity that directly relates to a population's potential to be self-sustaining, i.e., recruits per spawner, or the rate at which spawning adults in one generation are replaced by spawning adults in the next generation.

This measure of life-cycle productivity is affected by mortality and survival at all life stages, including juvenile mortality (such as the relative number or proportion of juveniles that die while migrating down river) and by adult mortality (such as the relative proportion of adult fish harvested) (Figure 5-1).

The gap analysis itself does not identify or target a particular life stage for actions to achieve viability criteria. Gaps can be addressed by improvements to survival rates at any life stage (e.g., tributary residence, migration, estuary, early ocean, upstream migration), depending on the specific factors limiting the individual populations.

The ICTRT (2007c) estimated the minimal survival rate changes needed for Middle Columbia steelhead populations to meet the abundance and productivity viability criteria for a 5 percent risk of extinction in a 100-year time frame.

They used the following steps to estimate observed survival gaps:

1. Estimated current intrinsic productivity (defined by TRT as reproductive rate at low abundance) and natural spawner abundance (using the most recent 20 years of stock-recruit data).
2. Estimated current spawning level associated with achieving juvenile capacity.
3. Assigned each population to a risk category (very low, low, moderate, or high risk) based on its position relative to the viability curve for its size category.
4. Calculated gaps based on the minimum distance from the abundance/productivity point representing current status and the appropriate viability curve.

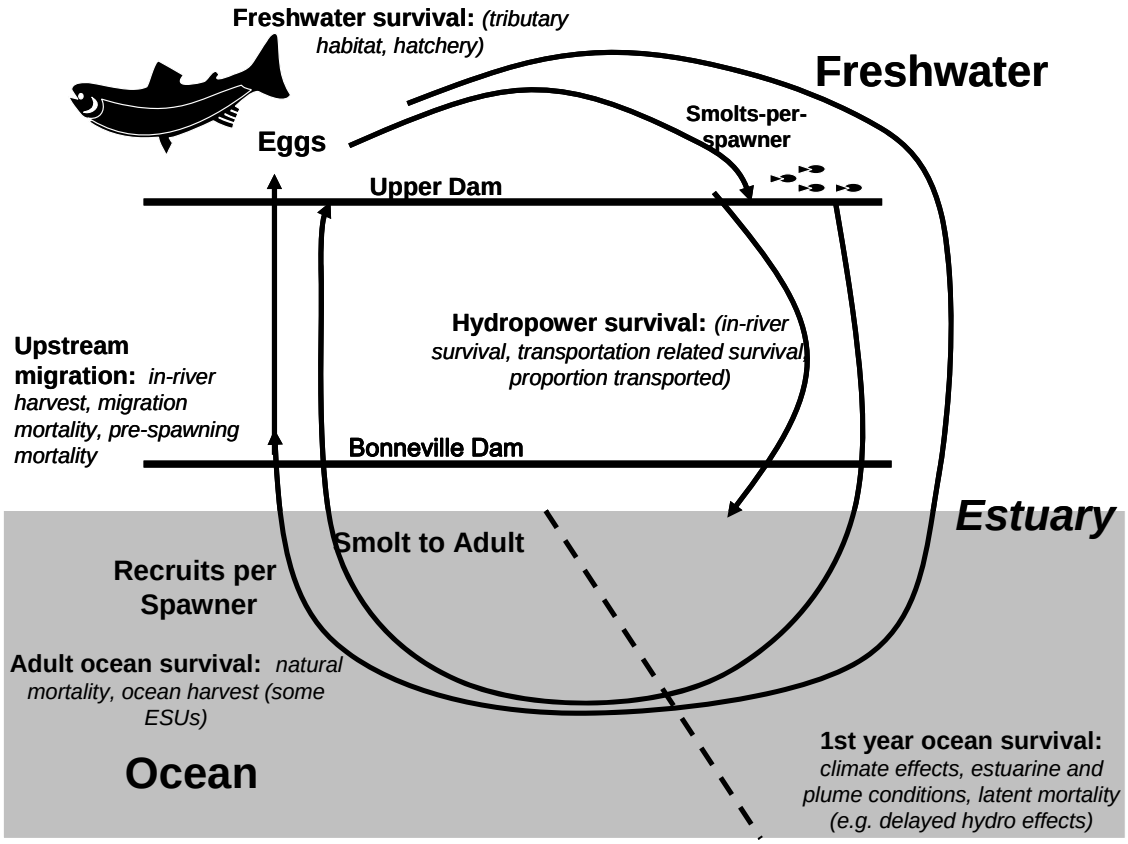


Figure 5-1. Survival and Mortality throughout Salmonid Life Cycle

In addition, the ICTRT (2007) estimated gaps under three different early-ocean survival scenarios; historical ocean conditions (ocean conditions that fish experienced over the past 60 years), pessimistic ocean conditions (ocean conditions experienced by the 1975-1997 brood years), and recent ocean conditions (ocean conditions experienced by fish during the 20-year assessment period). The ICTRT also estimated gaps assuming three different hydropower scenarios. However, only the base hydro condition, which assumed that survival rates from the most recent 20 years would continue into the future, is reported here. (See NMFS 2008 for details on survival through the FCRPS under proposed improvements.)

Changes in survivals of Middle Columbia steelhead needed to achieve 5 percent risk criteria for abundance and productivity in a 100-year time period are presented in Table 5-1. The numbers in the table are expressed as a proportion of current survival. For example, in the table, an estimated gap of 0.09 for Umatilla steelhead requires increasing average life-cycle survival by 9 percent, or a 1.09 fold increase, to achieve 5 percent risk in a 100-year time period. A negative (minus) number means the population is viable.

The median survival gap (assuming recent ocean and base hydrosystem conditions and 5 percent risk) for the Eastern Cascades MPG is 0.21, ranging from –0.34 (Deschutes Eastside) to 0.78 (Deschutes Westside). The Deschutes Eastside and Fifteen Mile populations exceed

the 5 percent abundance and productivity criteria under all ocean scenarios. In contrast, the Deschutes Westside fails to meet the criteria under all ocean scenarios. There was not enough information to estimate gaps for the Klickitat or Rock Creek populations.

The median survival gap for the John Day MPG is 0.09, ranging from –0.49 (North Fork) to 0.34 (South Fork). Two out of the five populations exceed the 5 percent abundance and productivity risk criteria under both the recent and historical ocean conditions. The North Fork population exceeds the 5 percent risk criteria under all ocean scenarios, while the South Fork population fails to meet the 5 percent criteria under all ocean scenarios.

There was sufficient information available to estimate gaps for only two of the three populations within the Umatilla/Walla Walla MPG. Assuming base hydrosystem and recent ocean conditions, the survival gaps for the Umatilla and Walla Walla populations are 0.09 and 0.34, respectively. The Umatilla population is projected to achieve the 5 percent risk criteria only under historical ocean conditions. The Walla Walla population fails to meet the 5 percent criteria under all ocean scenarios.

The median survival gap (assuming recent ocean and base hydrosystem conditions) for the Yakima MPG is 0.77, ranging from 0.22 (Satus—tributary only) to 1.15 (Upper Yakima). All populations in this MPG fail to meet the 5 percent criterion under all ocean scenarios.

Summary

The ICTRT modeled a gaps analysis for each of the four MPGs in this DPS under three different ocean conditions and a base hydro condition (most recent 20-year survival rate). The results showed that none of the MPGs would be able to achieve a 5 percent or less risk of extinction over 100 years without recovery actions.

Table 5-1. Minimum changes in survival of Middle Columbia River steelhead needed to meet abundance and productivity criteria for 5 percent risk curves in a 100-year time period under base hydropower conditions and three different ocean scenarios. Gap estimates are expressed as a proportion of current survival (e.g., a gap of 0.50 requires increasing average life-cycle survival by 50 percent (multiplying by 1.5) over recent averages).

NOTE: A negative (minus) number means there is no gap – the population is viable. Data are from Table 6b in ICTRT (2007c); NA = not available.

Major Population Group	Population	Estimated abundance/productivity gaps (5% risk in a 100-year time period)		
		Recent ocean survival	Historical ocean survival	Pessimistic ocean survival
Eastern Cascades	Deschutes W.	0.78	0.60	0.82
	Deschutes E.	No gap (-0.34)	No gap (-0.40)	No gap (-0.33)
	Klickitat	NA	NA	NA
	Fifteen Mile	No gap (-0.21)	No gap (-0.29)	No gap (-0.20)
	Rock Creek	NA	NA	NA
John Day	Lower Mainstem	0.11	0.00	0.14
	North Fork	No gap (-0.49)	No gap (-0.54)	No gap (-0.48)
	Upper Mainstem	0.00	No gap (-0.10)	0.02
	Middle Fork	0.09	No gap (-0.01)	0.12
	South Fork	0.34	0.21	0.37
Umatilla/Walla Walla	Umatilla	0.09	No gap (-0.01)	0.12
	Walla-Walla	0.34	0.21	0.37
	Touchet	NA	NA	NA
Yakima	Satus (tributary only)	0.22	0.10	0.25
	Toppenish	0.50	0.35	0.53
	Naches	1.03	0.83	1.08
	Upper Yakima	1.15	0.94	1.20

Note: These gaps do not constitute a legal determination of the status of Middle Columbia MPGs nor of the adequacy of any particular set of actions under the ESA. Rather, the gaps provide a sense of how much effort is needed for planning purposes.

6. LIMITING FACTORS AND THREATS

The reasons for a species' decline are generally described in terms of limiting factors and threats. NMFS defines limiting factors as the biological and physical conditions that limit a species' viability – e.g., high water temperature – and defines threats as those human activities or natural processes that cause the limiting factors. For example, removing the vegetation along the banks of a stream can cause higher water temperatures, because the stream is no longer shaded. Designing effective recovery strategies and actions requires understanding limiting factors and threats across the species' entire life cycle.

While the term "threats" carries a negative connotation, it does not mean that activities identified as threats are inherently undesirable. They are typically legitimate human activities that may at times have unintended negative consequences on fish populations—and that can also be managed in a manner that minimizes or eliminates the negative impacts.

This plan describes limiting factors and threats for the Middle Columbia steelhead DPS as a whole at a general level, then describes the most salient specific conditions that affect individual populations and limit the viability of specific MPGs. More detail is available in the individual management unit plans (Appendices A through E).

The discussion of out-of-subbasin limiting factors and threats that affect all the salmonid populations in the mainstem Columbia River corridor is excerpted from a "module" that NMFS prepared on the estuary and plume (NMFS 2007; available at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Other-Documents.cfm) and from the recently released 2008 FCRPS Biological Opinion (NMFS 2008). NMFS is preparing a hydro module to summarize FCRPS actions contained in the Biological Opinion. The hydro module will be available in fall 2008. There is no hatchery module; hatchery programs are widespread throughout the Columbia Basin and their population-specific effects are described in the individual management unit plans and their component subbasin plans. Hatchery reform actions are included in some of the management unit plans, and are also discussed in NMFS' Appendices C and D of the Supplemental Comprehensive Analysis of the FCRPS (NMFS 2008). Additional actions are expected to be identified through the Hatchery Scientific Review Group's work[32] and in hatchery management plans (e.g., Klickitat River Anadromous Fisheries Master Plan). These hatchery reform proposals will be addressed and implemented through the development of Hatchery and Genetic Management Plans (HGMPs), section 7 consultations, and the *U.S. v. Oregon* process.

6.1 Types of Limiting Factors

For purposes of this recovery plan, NMFS standardized descriptions of limiting factors into 12 categories or types. The descriptions of limiting factors in the management unit plans fit into these categories, although they may be lumped or split differently in the individual plan texts. Table 6-1 lists the 12 categories as "key" limiting factors, including the common

[32] www.hatcheryreform.us/prod/

characteristics used to describe them and the salmonid life stages they affect.[33] The first seven factors relate directly to habitat conditions, and the others to fish passage in upstream and downstream migration, the hydropower system, hatcheries, harvest, and predation/competition/disease.

Table 6-1. Key limiting factors and common characteristics used to describe them.

Key Limiting Factors	Common Characteristics	Life Stages Affected
1. Degraded estuarine and nearshore marine habitat	Inadequate large woody debris; loss of estuary complexity; loss of off-channel habitats; loss of intertidal, salt marsh and other functional estuarine and marine vegetation	egg-to-smolt survival, smolt migration, smolt-to-adult survival, adult migration
2. Degraded floodplain connectivity and function	Loss of off-channel habitat and floodplain connectivity, seasonal wetlands, wet meadows, side channels habitat; loss of connected and functional hyporheic zone.	egg-to-smolt survival, smolt migration, adult migration, pre-spawning
3. Degraded channel structure and complexity	Loss of pool frequency and quantity, large wood debris; channel straightening and confinement; simplified habitat; loss of spawning habitat structure, redd diversity; loss of sinuosity, insufficient instream complexity and roughness	egg-to-smolt survival, smolt migration, adult migration, pre-spawning
4. Degraded riparian area and LWD recruitment	Degraded riparian condition; loss of vegetation, shade, overhead cover, terrestrial food sources; unstable or eroding streambanks	egg-to-smolt survival, smolt migration, adult migration, pre-spawning
5. Altered hydrology	Higher peak flows, lower low flows; intermittent flow; increased stream energy; significant flow fluctuations on weekly, daily or hourly basis; dewatered channel	egg-to-smolt survival, smolt migration, adult migration, pre-spawning
6. Degraded water quality	High water temperatures, high level of chemical contaminants, nutrients, oxygen, pathogens, pH, toxic mine waste	egg-to-smolt survival, smolt migration, adult migration, pre-spawning
7. Altered sediment routing (degraded stream substrate)	Sedimentation; high levels of suspended sediment, turbidity, sediment load; increased fine sediments in spawning gravel; unnatural level of course-grained sediments; embedded substrate; contaminated sediment.	egg-to-parr survival
8. Impaired fish passage	Artificial barriers or obstructions, total or partially, obstructing habitat access (culverts, irrigation diversions, dams, seasonal push-up dams, unscreened diversions, and entrainment in irrigation diversions etc.)	smolt migration, adult migration, juvenile upstream migration due to thermal stress, water availability
9. Mainstem Columbia River hydro system	altered stream flows; impaired water quality, high water temperatures; impaired fish passage and survival; reduced mainstem spawning and rearing; increased predation and competition; degraded estuary and Columbia River plume habitat quality and quantity; degraded floodplains	egg-to-smolt survival, smolt migration, adult migration
10. Hatchery related adverse effects	Increased competition for food and space; increased predation; disease transfer; loss of genetic diversity	egg-to-smolt survival, smolt migration, adult migration
11. Harvest-related adverse effects	Decreased adult abundance (number of spawners or adult recruits) and productivity; influenced diversity and spatial structure through selective removal based on size, age, distribution or run timing	egg-to-smolt survival, adult survival
12. Predation/Competition/ Disease	Increase in predators; increased competition for food	egg-to-smolt survival, smolt-to-adult survival, adult survival

[33] These are the categories of limiting factors used for the yearly Pacific Coast Salmon Recovery Fund report to Congress.

6.2 Types of Threats

The "threats" contributing to the limiting factors and causes for a species' decline are often described in terms of the "four Hs" – habitat (usually relating to the effects of land use and tributary water use), hydropower, harvest, and hatcheries.

Habitat

For over 10,000 years, habitat conditions favorable to salmonid survival were widespread in the Northwest. Over the last 150 years, modern human activities have significantly reduced the extent and quality of salmonid habitat. For example, while Grand Coulee Dam, was a major engineering and economic triumph for a nation struggling through the Depression, it also permanently blocked salmon from hundreds of miles of habitat and ended the Native American economies that depended on those salmon. On a smaller scale, clearing land for agriculture or residential development, urban development, timber harvest, and road building all alter patterns of runoff, resulting in erosion and delivery of sediment and various pollutants to the streams. Water withdrawn from streams for urban, agricultural, and municipal use results in reduced or altered instream flows. To the extent that these activities result in degraded habitat for fish and wildlife, they are classified as threats.

Hydropower

Dams for hydropower, flood control, and/or storage significantly alter river conditions for migrating juvenile and adult steelhead and cause both direct and indirect mortality. The effects of the Federal Columbia River Power System (FCRPS) dams are described in more detail in Section 6.3.2.

Harvest

Harvest rates, methods and timing, bycatch, and indirect mortality from catch and release fisheries all affect fish survival. Fisheries management affecting Middle Columbia steelhead is described in more detail in Section 6.3.7.

Hatcheries

Hatcheries can be managed primarily for production of fish for harvest, primarily for conservation and recovery, or both. Depending on how they are used, hatcheries may increase or decrease the viability of listed fish populations. Potentially deleterious effects of hatcheries on Middle Columbia steelhead are discussed in more detail in Section 6.3.4.

6.3 Limiting Factors and Threats for the Middle Columbia Steelhead DPS

At the DPS level, based on information from the ICTRT and the four management unit plans, the major factors limiting the viability of Middle Columbia steelhead populations are *tributary habitat conditions*, *impaired fish passage in the mainstem Columbia River*, *hatchery related effects, and predation/competition/disease.*

The impact of mainstem passage varies depending on how many dams the populations must pass—between one and four for different Middle Columbia steelhead populations (see Figure 6-1).

Most of the management unit plans rate the importance of the limiting factors in their respective subbasins by population and also by smaller units such as stream reaches. There

are some differences of opinion as to the general, relative importance of tributary habitat limiting factors vs. passage conditions in the mainstem Columbia. However, all of the plans list both as major limiting factors.

In some tributary systems, local hydro-development also blocks fish passage (Pelton Dam on the Deschutes and Condit dam on the White Salmon) and results in flow modifications that affect water quality, habitat conditions, and predation rates (Pelton Dam on the Deschutes and Roza and Chandler Power Plants in the Yakima River system). Water management for agricultural irrigation alters seasonal flow patterns with serious consequences for steelhead rearing and both juvenile and adult migration in the Umatilla, Willow Creek, John Day, Deschutes, and especially the Yakima and Walla Walla basins. Hatchery related effects on genetic diversity and productivity are considered a major limiting factor for populations in the Deschutes, John Day, and Umatilla basins, and possibly the Klickitat. Two factors, degradation of estuarine and nearshore marine habitat and harvest-related effects, pose some risk to steelhead viability for the entire DPS, but less than the other factors.

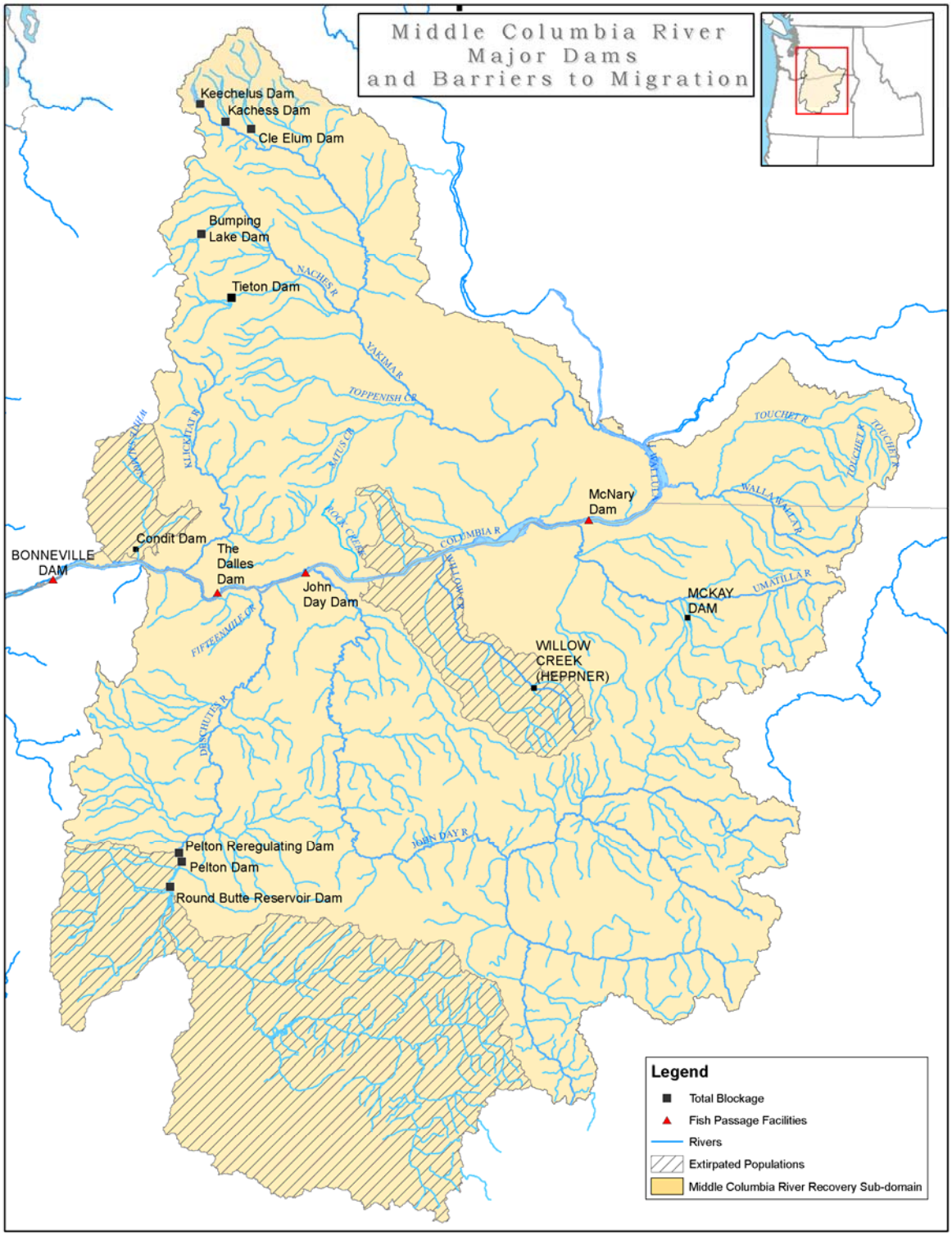


Figure 6-1. Major Dams and Barriers to Migration for Middle Columbia Steelhead

6.3.1 Tributary habitat conditions

Tributary habitat degradation from past and/or present land use remains a key concern for all of the populations. Historically, ecosystem conditions allowed steelhead populations in the spawning range of this DPS to grow and prosper. Extensive beaver activity created diverse instream habitats, with deep pools and strong connections to floodplains. Many stream channels contained abundant large wood from surrounding riparian forests, which included cottonwood, aspen, willow, and upstream conifers. Stream temperatures sufficient to support all steelhead life stages throughout the year were common. Upland and riparian conditions allowed for the storage and release of cool water during the dry, summer months and provided sufficient shade to keep water temperatures cool. Extensive and abundant riparian vegetation armored streambanks, providing protection against erosion and supporting an abundant food supply. Dynamic patterns of channel migration in floodplains continually created complex channel, side channel, and off-channel habitats.

The conditions that steelhead populations encounter in the Middle Columbia region have changed considerably over the last 150 years. Today, nearly all historical habitat lies in areas modified by human settlement and activities. Historical land use exerted a large and widespread impact on steelhead habitat quality and quantity across the DPS. Common historical practices included removal of wood from streams; removal of riparian vegetation; timber harvest, road construction, agricultural development, livestock grazing, urbanization, wetland draining, and gravel mining; alteration of channel structure through stream relocation, channel confinement and straightening; beaver removal; construction of dams for multiple purposes; and direct withdrawal of water for irrigation or human consumption.

While some streams and stream reaches retain highly functional habitat conditions, these various activities have degraded streams and stream reaches across the range of the Middle Columbia steelhead DPS, leaving them with insufficient large wood in channels, insufficient instream complexity and roughness, and inadequate connectivity to associated wetlands and off-channel habitats. Many streams lack sinuosity and associated meanders, and suffer from excessive streambank erosion and sedimentation, as well as altered flow regimes and higher summer water temperatures. In many areas, the contemporary watershed conditions created by past and current land use practices are so different from those under which native fish species evolved that they now pose a significant impediment to achieving recovery. The management unit plans contain detailed descriptions of tributary habitat threats and limiting factors.

6.3.2 Impaired fish passage in Columbia River mainstem

All populations of Middle Columbia steelhead use the mainstem Columbia River to migrate to and from the ocean, and all are affected by the mainstem Federal dams. Development and operation of the mainstem Columbia River hydropower system significantly alters travel conditions in the mainstem Columbia River, resulting in direct mortality of both upstream migrating adults and downstream migrating steelhead kelts, and direct and indirect mortality for downstream migrants (juveniles). The hydro system also changes the hydrograph, depleting historically available nutrients, changing water temperatures, and degrading rearing

and food resources for both presmolts and smolts in the Columbia. Changes in the hydrograph leave steelhead more vulnerable to bird and fish predation in the Columbia River estuary and mainstem. In addition, broad deltas have been created at the mouths of tributaries where fine sediment has been deposited. These conditions have resulted in increased non-native piscivorous and avian predation on juveniles.

All these impacts increase somewhat for each population in direct relation to the number of dams that fish must pass during their migration to and from the Pacific Ocean. Middle Columbia steelhead populations pass one to four Columbia River dams: the Fifteenmile and Klickitat populations pass the Bonneville Dam; the Deschutes populations pass Bonneville and The Dalles dams; the John Day, Rock Creek, and Umatilla populations pass Bonneville, The Dalles, and John Day dams; and all four populations of the Yakima MPG as well as the Walla Walla and Touchet populations pass Bonneville, The Dalles, John Day, and McNary dams (Figure 6-1). While hydropower system impacts are less for Middle Columbia steelhead than for the listed Interior Columbia salmonids that must pass up to nine mainstem dams, they still substantially affect most Middle Columbia populations.

Chapter 8 of the Oregon Steelhead Recovery Plan provides detailed information concerning the effects of the FCRPS on Middle Columbia steelhead; however, because of a lack of specific survival data for the Middle Columbia DPS, much must be inferred from studies of hatchery steelhead or Snake River steelhead. Table 6-2 shows current estimates of survival of **juvenile** Middle Columbia steelhead migrating downstream through one to four dams. These estimates are based on COMPASS modeling of a 70-year water record (source: NMFS 2008 Supplemental Comprehensive Analysis—Hydro Modeling Appendix). They represent current conditions, reflecting improvements in the hydropower system made within the last decade. Survival is estimated at 90, 73, 54, and 48 percent, respectively, for juvenile passage through one to four dams. Juvenile mortality, conversely, is estimated at 10, 27, 46, and 52 percent.

Table 6-2. Middle Columbia River Steelhead DPS Juvenile Survival (migrating downstream) (Source: NMFS 2008 Supplemental Comprehensive Analysis—Hydro Modeling Appendix)

Population	Dams	% Survival
Fifteenmile	Bonneville	90
Klickitat		90
Deschutes West	The Dalles Bonneville	73
Deschutes East		73
Rock Creek	John Day The Dalles Bonneville	54
Lower Mainstem John Day		54
North Fork John Day		54
Upper Mainstem John Day		54
Middle Fork John Day		54
South Fork John Day		54

Population	Dams	% Survival
Umatilla		54
Walla Walla	McNary John Day The Dalles Bonneville	48
Touchet		48
Upper Yakima		48
Naches		48
Toppenish		48
Satus		48

Table 6-3 shows current estimates of **adult** survival for Middle Columbia steelhead migrating upstream through the dams.[34] These estimates are based on PIT-tagged steelhead from the Snake River as "surrogates." Adult steelhead survival is relatively high through the lower Columbia River dams and reservoirs as a result of dam operations and effective fish ladders.[35] There are known losses of adult fish approaching Bonneville Dam from marine mammal predation. For summer-run populations, this impact is likely minimal. For winter-run populations (Fifteenmile Creek, Klickitat, and possibly Rock Creek), the current impact may be as high as 22 percent (Source: NMFS 2008 Supplemental Comprehensive Analysis, Marine Mammal Predation Appendix).

Table 6-3. Middle Columbia River Steelhead DPS Adult Survival (migrating upstream) (Source: NMFS 2008 Supplemental Comprehensive Analysis, Adult Survival Estimates Appendix)

Population	Dams	% Survival
Fifteenmile	Bonneville	>98.5
Klickitat		>98.5
Deschutes West	Bonneville The Dalles	98.5
Deschutes East		98.5
Rock Creek	Bonneville The Dalles John Day	97
Lower Mainstem John Day		97
North Fork John Day		97

[34] Adult steelhead detected at Bonneville Dam constitute the starting population for making survival rate estimates based on PIT tags. Consequently, no estimates of survival from the Bonneville tailrace to the detectors in the ladder are included in these estimates. However, based on the high inter-dam survival rates, this impact is likely small, except for winter-run populations, which may be substantially impacted by marine mammal predation in the Bonneville tailrace.

[35] It should be noted, however, that there are uncertainties in PIT-tag data for Upper Columbia steelhead compared to Snake River steelhead for the most recent two years, and it is not yet known how to interpret those data or how they apply to Middle Columbia steelhead adult survival estimates.

Population	Dams	% Survival
Upper Mainstem John Day		97
Middle Fork John Day		97
South Fork John Day		97
Umatilla		97
Walla Walla	Bonneville The Dalles John Day McNary	95
Touchet		95
Upper Yakima		95
Naches		95
Toppenish		95
Satus		95

6.3.3 Impaired fish passage in tributaries

Many kinds of land and water use can result in seasonal or total blockages to fish passage, or changes in the range of conditions that make fish migration possible. Impaired fish passage is identified as a key or secondary limiting factor for all populations in the Middle Columbia steelhead DPS. Dams, culverts, seasonal pushup dams, and unscreened diversions can directly prevent migration; seasonal areas of high water temperature, low flow, or dewatering can also function as barriers. Large dams affect fish passage on the Deschutes, Yakima, Umatilla, and White Salmon rivers. The Pelton-Round Butte Dam Complex on the Deschutes River blocks fish passage to upstream habitat on the Deschutes, Crooked, and Metolius rivers and smaller tributaries. Condit Dam blocks steelhead access to historical habitat on the White Salmon River. Five storage dams – Cle Elum, Kachess, Kechelus, Bumping Lake, and Tieton, block historical habitat in the Yakima River basin. Bennington Dam, east of the City of Walla Walla on Mill Creek, a tributary of the Walla Walla River, was without fish passage until the 1980s. Subsequent improvements provide only partial passage, and Bennington Dam remains a significant passage obstruction that affects Walla Walla River steelhead. Numerous smaller barriers block or impair access to smaller tributaries throughout the basin.

6.3.4 Hatcheries

Hatchery fish that stray into Middle Columbia tributaries and spawn naturally may represent a serious threat to steelhead recovery. More than 100 hatchery programs operate in the Columbia Basin above Bonneville Dam, mostly for the purpose of providing fish for harvest to mitigate losses caused by the FCRPS. Some hatchery programs may provide conservation benefits; however, hatchery programs also pose threats to natural-origin steelhead in some Middle Columbia watersheds. Hatchery-induced genetic change can reduce the fitness of both hatchery and natural-origin fish in the wild, and hatchery-induced ecological effects (competition for food and space) can reduce population productivity and abundance. In particular, hatchery programs designed to return summer steelhead to upstream Columbia River tributaries result in substantial numbers of stray hatchery steelhead spawning naturally among several Middle Columbia populations. Concern exists regarding the continuing

detrimental impact of these stray out-of-DPS hatchery fish in natural spawning areas on the genetic composition and productivity of naturally produced Middle Columbia River steelhead populations. A large body of data indicates that steelhead of non-local origin can decrease the productivity and genetic diversity of natural populations (Fleming & Peterson 2001; McGinnity et al. 2003; Berejikian & Ford 2004, Myers et al. 2004). A recent study suggests that any interbreeding of hatchery-origin and naturally produced fish can pose risks to species fitness (Araki et al. 2007). The study suggested that use of natural-origin steelhead in a supplementation-type program is a possible strategy of increasing wild adults after one generation (Araki et al 2007), but cautioned that long-term effects of supplementation are at present unknown and therefore a cause for concern in terms of potential impacts on fitness.

Hatchery related threats or potential effects are substantial for the Deschutes Westside, Deschutes Eastside, Lower Mainstem John Day, and Umatilla populations, which are all currently threatened by stray out-of-basin and out-of-DPS hatchery fish. Out-of-DPS hatchery-origin spawners are estimated at 29 percent for Deschutes Eastside, 15.2 percent for Deschutes Westside, from 10 to 18 percent for Lower Mainstem John Day, and 5 percent for the Umatilla population (source: draft ICTRT Current Status Summary, Cooney 2008).

Hatcheries may also affect the Klickitat population because of releases of non-nativeSkamania stock hatchery fish in the Klickitat River. More data are needed to determine the effects on the productivity of the Klickitat population.

Another uncertainty is the effect of all the combined hatchery releases on estuarine food supplies and predation rates in the estuary (discussed further in Estuary Module). Pacific salmon at all abundance levels and at all life stages are subject to density dependent processes. Many factors influence these processes, including changes in habitat quality and quantity, prey base, the abundance and distribution of predators, natural fluctuations in environmental conditions (e.g., summer stream flows and ocean productivity), and interactions among species and between natural and hatchery fish that depend on the same natural environments. The question is how and to what extent hatchery-origin fish, in combination with these and other factors, affect density dependent processes and the growth and survival of natural-origin fish. There is increasing evidence of density dependent effects on salmon and steelhead growth and survival, but the underlying factor or factors remain poorly understood. Evaluating the factors that influence or drive density dependent effects under different freshwater (e.g., hydrosystem), estuarine, and ocean conditions is an important area of future research.

6.3.5 Predation/competition/disease

Anthropogenic changes in the Columbia River have altered the relationships between salmonids and other fish, bird, and pinniped species.

6.3.5.1 Pinnipeds

The abundance of native pinnipeds has steadily increased since passage of the Marine Mammal Protection Act in 1972. During the spring salmonid migration season, Steller sea lions and California sea lions prey on salmon and steelhead in the Lower Columbia River as far upstream as the Bonneville Dam. The sea lions are estimated, based on visual

observations and steelhead counts at Bonneville Dam, to consume 7.8 percent of winter-run steelhead (source: Marine Mammal Appendix, 2008 FCRPS BiOp). However, comparisons of radio-telemetry data indicate that the consumption rate of spring Chinook salmon is likely 2.8 times higher (8.5 percent by radiotelemetry versus 3.0 by observation) than estimated using observational data alone. Applying this correction factor to winter-run steelhead would yield an estimate of 21.8 percent. Based on the relatively low numbers of steelhead passing Bonneville Dam during the winter months (0 to 140 individuals per day – Columbia River DART adult passage data for 2005 to 2008), even a small number of sea lions would be capable of consuming approximately 20% of the migrating winter steelhead (source: NMFS 2008, Supplemental Comprehensive Analysis, Marine Mammal Appendix). This may be a significant impact on the winter-run steelhead in the Middle Columbia DPS (primarily Fifteenmile Creek and Klickitat populations). Because of their migration timing, the summer-run steelhead populations that make up the bulk of the DPS are likely not substantially affected by pinniped predation.

A pinniped hazing program has been implemented at Bonneville Dam since 2005, but the efforts have largely been ineffective. Under section 120 of the Marine Mammal Protection Act, states can ask for permission to kill individually identifiable sea lions or seals that are having a "significant negative impact" on at-risk salmon and steelhead, and NMFS can grant that permission, if certain legal standards are met. In March 2008, NMFS granted the request of the states of Oregon, Washington, and Idaho to lethally remove problem California sea lions. Any animals that are captured may be euthanized if no permanent holding facility can be found for them. NMFS and representatives of zoos and aquariums are compiling a list of pre-approved permanent holding facilities interested in receiving a limited number of captured sea lions as an alternative to euthanasia. NOAA has authorized the states to remove as many as 85 animals annually, but estimates that only about 30 animals will be removed each year, given the conditions in its authorization.

6.3.5.2 Birds

Estuary habitat modifications have increased the number and/or predation effectiveness of Caspian terns, double-crested cormorants, and a variety of gull species. Juvenile steelhead, including Middle Columbia steelhead, are most vulnerable to predation by Caspian terns because they migrate at relatively shallow depths in deep water habitat channels that have relatively low turbidity and are close to island tern habitats (NMFS 2007; NMFS 2008; Collis et al. 2007; Roby et al. 2007). They also tend to be larger than juveniles of other salmonid species. Caspian terns began nesting on East Sand Island in the Columbia estuary (RM 5) in 1984 and on Rice Island (RM 21) in 1986. The islands were formed by U.S. Army Corps of Engineers' disposal of dredged material. On September 15, 1999, NMFS required the Corps to modify habitat on Rice Island to eliminate nesting habitat for Caspian terns. Since 2001, no Caspian terns have nested on Rice Island, resulting in reduced predation of juvenile salmonids from 11.7 million fish in 1999 to 6.5 million fish in 2002. Although total consumption of juvenile salmonids by terns was reduced considerably, a 2007 study found that predation rates on steelhead were 2-12 times higher than those for other salmonid species and run types (Roby et al. 2007). Based on smolt PIT tag recoveries on the East Sand Island Caspian tern colony, predation rates on steelhead smolts were particularly high during 2007, at about 12.5% for in-river migrant smolts and 7.7% for transported smolts.

Avian predation is also significant farther inland in the Middle Columbia region. Avian predator colonies on islands in the Columbia River include Caspian terns, double-crested cormorants, ring-billed and California gulls, and American white pelicans. The most significant populations of avian predators occur on Crescent Island (Caspian terns) and Foundation Island) cormorants), which are located in the Columbia near the mouth of the Snake River. In 2000 and 2001, bioenergetics modeling was used to estimate the smolt consumption rate of the Crescent Island tern colony at 465,000 and 679,000 smolts, respectively (Antolos et al. 2005). Approximately 25 percent of this consumption consisted of steelhead, including steelhead from the Yakima basin.

In 2005, an estimated 1 percent (22) of PIT tags from outmigrating Yakima River steelhead were subsequently recovered on the Crescent Island Caspian tern colony. In 2004, the figure was 2 percent (A. Evans, Real Time Research Inc., personal comm. 2006, as cited in the Yakima Recovery Plan). In 2005 only 0.1 percent (3 PIT tags) of PIT-tagged Yakima River steelhead were recovered on the Badger Island pelican colony (located just downstream from the mouth of the Yakima with more than 1057 adult birds present). PIT tag recoveries from the Foundation Island colony of double-crested cormorants, situated 8 km upstream of Crescent and Badger islands indicated an overall steelhead predation rate about one-fifth as great as for the tern colony, though this is changing as tern numbers drop and cormorant numbers increase (Collis and Roby 2006). These rates do not account for ingested PIT tags deposited off the colonies, or for mortality (at least 50 percent for Yakima steelhead) of tagged fish between release sites and the Yakima River's mouth (Yakima Recovery Plan).

6.3.5.3 Piscivorous Fish

The dams on the Columbia River alter habitat conditions in several ways that are favorable to both native and nonnative fish species that prey on juvenile salmonids (NMFS 2008). A recent report from the Independent Scientific Advisory Board, an appointed group of scientists advisory to the NPCC, Columbia River Basin Indian Tribes, and NMFS, summarizes these effects and concludes that predation by nonnative species is as significant as habitat loss and degradation in imperiling native freshwater species (ISAB 2008). The primary resident fish predators are northern pikeminnow (native), smallmouth bass (introduced), and walleye (introduced) (NMFS 2008). Other predatory resident fish are channel catfish (introduced), Pacific lamprey (native), yellow perch (introduced), largemouth bass (introduced), and bull trout (native).

Impacts of the northern pikeminnow are concentrated in the lower Columbia River from The Dalles reservoir downstream, where the estimated predation loss is 8 percent of the approximately 200 million hatchery and wild juvenile salmonid migrants in the system (NMFS 2008). The highest densities of smallmouth bass in the Columbia and Snake Rivers occur in the Lower Granite forebay, tailrace, and reservoir, followed by the John Day Reservoir (NMFS 2000a). Throughout the John Day Reservoir study area, smallmouth bass consumed far fewer juvenile salmonids than did northern pikeminnow (Zimmerman 1999). Walleye are also most abundance in the tailraces of the dams (NMFS 2008). In the 1983-1986 John Day Reservoir study that forms the basis for the current predator management program, Rieman et al. (1991) found that walleye consumed 13 percent of the estimated

annual 2.7 million juvenile salmonids consumed by predatory fish. Northern pikeminnow accounted for 78 percent and smallmouth bass took 9 percent (cited in NMFS 2008).

6.3.5.4 Competition

Changes in habitat and high numbers of hatchery fish releases can also affect competitive relationships, resulting in increased competition between steelhead and other species for food and habitat (NMFS 2008; ISAB 2008). Competition is often discussed in terms of density dependence. Density dependence refers to changes in the size of a population that are themselves a result of the size of the population, such as when a population declines because it has exceeded the amount of resources available to support it (NMFS 2007). Density dependent mortality can occur through several mechanisms, such as direct competition for limited food and habitat and changes in the foraging activity of predators. With salmon and steelhead, density dependent mortality can occur at any stage in the animal's life cycle and may be exacerbated by the introduction of large numbers of hatchery fish released over a relatively short period of time.

How much density dependent mortality is taking place in the estuary compared to in the ocean is unclear. There is some evidence that density dependent mortality is occurring in the open ocean. For example, during years when salmon are especially numerous in the ocean, their growth rates are reduced (Peterman 1984 as cited in Ford 2007). However, another study found no connection between ocean conditions and density dependent mortality, which appeared to be occurring among wild Snake River chinook as hatchery steelhead were released (Levin and Williams 2002 as cited in Ford 2007). The authors suggested that the apparent density dependent mortality could be better explained by interactions in the tributaries or estuary than by interactions in the ocean.

There is growing awareness among scientists studying the Columbia River estuary that mechanisms related to density dependence may limit salmon and steelhead while they are using estuary and plume habitats. Scientists studying Skagit River fall chinook have documented density dependence-related mortality as a result of loss of habitat in the Skagit estuary and believe that such mortality can be attributed to a 75 percent loss of tidal delta estuarine habitat (Beamer et al. 2005). With similar habitat losses in the Columbia River estuary, it is possible that too many fish are competing for limited habitat and associated resources in the estuary at key times, and that the resulting stressors translate into reduced salmonid survival. NOAA/NMFS's Northwest Fisheries Science Center currently is investigating potential density dependent mortality in the estuary.

6.3.5.5 Disease

Steelhead can be infected by a variety of bacterial, viral, fungal, and microparasitic pathogens. Numerous diseases may result from pathogens that occur naturally in the wild or that may be transmitted to wild fish via infected hatchery fish. Very little current or historical information exists to quantify changes in infection levels and mortality rates attributable to these diseases for steelhead. However, studies have shown that naturally spawned fish tend to be less susceptible to pathogens than hatchery-reared fish (Buchanon et al., 1983; Sanders et al., 1992). Native salmon populations have co-evolved with specific communities of these organisms, but the widespread use of artificial propagation has introduced exotic organisms

not historically present in a particular watershed. Habitat conditions such as low water flows and high temperatures can exacerbate susceptibility to infectious diseases. Fish weakened by disease are more sensitive to other environmental stresses, and may become more vulnerable to predation or less able to compete with other species. Aggressive hatchery reforms implemented in some areas have reduced the magnitude and distribution of hatchery fish releases, and consequently the interactions between hatchery- and natural-origin fish and the potential transmission of infectious diseases. Additionally, regulations controlling hatchery effluent discharges into streams have reduced the potential of pathogens being released into steelhead habitats. There is little or no information on specific impacts or trends in disease among Middle Columbia steelhead.

6.3.6 Degradation of estuarine and nearshore marine habitat

The estuary serves an important role beyond simply providing a corridor that Interior Columbia populations use to migrate between freshwater and the ocean. The estuary is part of the continuum of ecosystems that salmon and steelhead use to complete their life cycles. A variety of anthropogenic factors and natural changes to the estuary have affected all VSP parameters, particularly alterations in flows, loss of emergent marsh, tidal swamp, and forested wetlands, shifts in organic matter important to estuarine food webs, and changes in the plume. Changes in the plume may have a greater effect than changes in shallow-water habitat on salmonids with yearling life history strategies such as the Middle Columbia steelhead DPS. Exposure to waterborne and sediment-associated chemical contaminants such as pesticides and dissolved metals can also affect productivity of salmon and steelhead. Finally, predation in the estuary is a major source of mortality on both adults and juveniles of all listed populations. These issues are discussed in greater detail in the Estuary Module (NMFS 2007)

6.3.7 Harvest

Fisheries of the Columbia River are established within the guidelines and constraints of the Pacific Salmon Treaty, the Columbia River Fish Management Plan, the ESA administered by NMFS, the Pacific Fishery Management Council, the states of Oregon and Washington, the Columbia River Compact, and management agreements negotiated between the parties to *U.S. v. Oregon*. Fisheries management through these various organizations has resulted in the decline of total exploitation rates for Columbia River salmon and steelhead, especially since the 1970s. Because of these changes, the ICTRT currently considers harvest a secondary limiting factor for Oregon Middle Columbia steelhead populations.

Ocean Fisheries. It is assumed that steelhead are rarely caught in ocean fisheries because they tend to be distributed offshore of major fishing areas and are therefore not readily available. According to Rich (1942), Columbia River steelhead were historically taken along with Chinook and coho in ocean fisheries off the mouth of the Columbia River, but accounted for less than 0.1 percent of the catch and numbered only in the few hundreds of fish. Current ocean fisheries generally target Chinook and coho salmon, and interception of steelhead is believed to be rare. If caught, steelhead must be released. Creel surveys on recreational ocean fisheries recorded less than 100 steelhead (of any DPS) caught each year from 2003 to 2005. Of these, less than 10 were estimated to be released wild fish mortalities. Ocean fishing mortality on Middle Columbia River steelhead is assumed to be zero.

Mainstem Columbia Fisheries. Harvest rates on this DPS in the past, e.g. prior to 1975, were estimated at 65 percent in fisheries occurring in the Columbia River. Current rates are much lower. There has been no direct freshwater non-tribal harvest on wild steelhead from the Middle Columbia DPS since 1992, when the last wild fish catch and release regulations on these populations became effective. Therefore, all current non-tribal harvest impacts on Middle Columbia DPS steelhead are due to incidental bycatch in commercial or recreational fisheries that target hatchery steelhead or other species. Monitoring these impacts is complex. Information assessing catch and release mortality of adult steelhead is limited. However, available information suggests that hook-and-release mortality is low. Hooton (1987) found catch and release mortality of adults in winter steelhead fisheries to be, on average, less than 5 percent when using barbed and barbless hooks, bait and artificial lures; Hooton (1987) concluded that catch and release of adult steelhead was an effective mechanism for maintaining angling opportunity without negatively impacting stock recruitment. Reingold (1975) showed that adult steelhead hooked, played to exhaustion, and then released returned to their target spawning stream as well as steelhead not hooked and played to exhaustion. Similarly, Nelson et al. (2005) observed that the catch and release mortality for radio-tagged wild winter steelhead was 2.5 percent and that tagged steelhead survived to spawning even after be caught and released up to three times. Mongillo (1984) and Rawding (2000) reported a strong correlation between water temperature and catch and release mortality with water temperatures below 50F (10C) providing optimal survival, while temperatures above 60F (15.5C) increase the mortality rate. Recreational fisheries are monitored by creel surveys (fisheries technicians interview anglers about their catch, gear, and wild steelhead releases).

Three stocks of summer steelhead are used for management of treaty and non-treaty mainstem fisheries: lower river Skamania stock, upriver A-run stock, and upriver B-run stock. All Middle Columbia steelhead populations are designated A-run, with two populations being winter-run. In NOAA Biological Opinion for the 2008-2017 *U.S. v. Oregon* Fisheries Agreement, the wild MCR steelhead DPS in the non-treaty winter, spring, and summer mainstem fisheries are subject to a 2 percent harvest rate limit (NMFS 2008). Non-treaty fall fisheries are also limited to a 2 percent harvest rate limit for A-run summer steelhead. The total annual harvest rate limit for A-run steelhead in non-treaty fisheries is 4 percent and 2 percent for the summer-run and winter-run of the MCR steelhead DPS respectively. The expected harvest impacts from non-treaty fisheries are less than the limits proposed in the *U.S. v. Oregon* Fisheries Agreement. The yearly incidental catch of A-run steelhead in non-treaty fisheries has averaged 1.6 percent since 1999, and are not expected to change over the course of the Agreement (NMFS 2008).

Tribal fishers in Zone 6 of the Columbia mainstem (between Bonneville Dam and McNary Dam) continue to retain wild steelhead for commercial sale or for personal use. The *U.S. v. Oregon* Fisheries Agreement does not establish specific harvest rate limits for treaty Indian fisheries on steelhead during the spring or summer seasons, which extend through July 31. Reported steelhead catch in Zone 6 winter and spring fisheries for 2003 to 2005 ranged from 0.7 percent to 7.9 percent of the winter steelhead run over Bonneville Dam. In 2004, reported and estimated non-reported steelhead catch together amounted to 4.8 percent of the run at Bonneville, with an unknown error around these numbers (Oregon Steelhead Recovery Plan, p. 8-98-99).

Impacts on MCR steelhead from Treaty Indian fall fisheries are limited by harvest rate limits for B-run steelhead and Upper Columbia River bright fall Chinook (NMFS 2008). The harvest rate on MCR summer-run steelhead in spring, summer, and fall Zone 6 Treaty Indian fisheries combined averaged 11.7 percent since 1985 and 6.64 percent since 1998 (Table 8.8.5.5-1; NMFS 2008). The impacts resulting from the Treaty Indian fisheries are expected to be similar to the 1998-2006 average of 6.64 percent. The harvest rate is less for populations that pass fewer dams in Zone 6 and are therefore subject to fewer non-Indian and treaty Indian fisheries (e.g. Klickitat steelhead pass only one dam and experience a harvest rate estimated at less than 10 percent).

Oregon and Washington have proposed regulations for tributary recreational fisheries in FMEPs submitted to NOAA Fisheries for approval under the limit 4 of the 4(d) rule. WDFW estimates that in 2002 fisheries, the impacts on MCR steelhead from all fisheries were 7.5 percent for the Treaty Columbia River mainstem and tributary fisheries, < 4.0 percent for the non-treaty Columbia River mainstem fisheries, and 0.3 percent in Washington tributaries for a total impact of less than 12 percent (WDFW 2008).

ODFW performed a number of Population Viability Assessment model runs for 27 steelhead populations to assess the impact of fisheries mortality on the status and recovery of steelhead in Oregon (Chilcote 2001). The model looked at a range of fisheries mortalities from 0 percent to 75 percent. The results were stated in terms of the probability of the population becoming extinct in 50 years at each fisheries mortality rate. For most populations the modeling suggested that the probability of extinction was essentially zero as long as fisheries mortality rates remained less than 30 percent. As mortality rates became greater than 40 percent, the probability of extinction increased dramatically. Furthermore, once the probability of extinction increased beyond 0.05, the transition to an extinction probability of 1.00 was very rapid. In other words, once mortality rates increase sufficiently to cause the probability of extinction to exceed 0.05, any additional mortality would cause a rapid increase in the likelihood of extinction. Because the transition from low to high risk happens so rapidly, there is little room for error (in the model or the measurements of mortality rates). To address this concern, ODFW will manage steelhead fisheries not to exceed a maximum fisheries mortality limit to 20 percent. This conservative approach was used to provide a buffer for errors, even though the model results suggested that management under a 40 percent limit was unlikely to cause extinction.

6.3.8 Other Factors Affecting Survival in the Columbia River Mainstem

Water temperature and thermal refuges. Optimal water temperatures for steelhead and salmon vary with life stage, but in general the optimal range is 11-15°C (52-59°F) and temperatures above 25°C (77°F) can be lethal. Alterations in water temperature affect the metabolism, growth rate, and disease resistance of salmonids, as well as the timing of adult migrations, fry emergence, and smoltification. As a result of the operation of the 14 FCRPS dams, in some areas and seasons the Columbia River is colder, and in others warmer, than before the dams (SCA Ch.5, NMFS 2008). Since 1938, summer water temperatures at Bonneville Dam have increased 4 degrees on average (Lower Columbia Fish Recovery Board 2004). Among-year variability in temperature has been reduced by 63 percent since

1970 (Lower Columbia Fish Recovery Board 2004). Temperatures in the estuary exceed 20° C earlier in the year and more frequently than they did historically (National Research Council 2004). Coincident with and possibly due to climate change, average annual Columbia Basin air temperatures have increased by about 1 degree C over the past century and water temperatures in the mainstem Snake and Columbia rivers have been affected similarly (ISAB 2007). On the other hand, at some times of year temperatures in the lower Snake River may be lower than before, due to the release of colder water from the four lower Snake dams. This latter change has complex consequences; post-impoundment water temperatures may stay cooler longer into the spring and warmer later into the fall (called "thermal inertia"), and this in turn may affect adult migration, spawn timing, and juvenile emergence, rearing, and outmigration timing (SCA, NMFS 2008).

When water temperatures are high, the fish may take refuge in cooler areas at the mouths of tributaries, and therefore delay migration and spawning or stray into the cooler rivers. It is possible that the Snake River hatchery steelhead that spawn in the Deschutes and John Day rivers are initially attracted to the thermal refuges at the mouths of these rivers.

Changes in mainstem nearshore habitat. The mainstem nearshore environment has been changed by ports, population centers, railroad tracks, and highways, where riparian vegetation has been replaced by riprap and docks.

6.3.9 Climate Change

Climate change represents a potentially significant threat to recovery of Middle Columbia steelhead populations. The Independent Scientific Advisory Board (ISAB) for the Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and NMFS reviewed the potential effects of climate change on salmonids in the Columbia River basin (ISAB 2007). The ISAB report shows that changes in climate may adversely affect steelhead in freshwater habitats across the DPS by exacerbating existing problems with water quantity (lower summer streamflows) and water quality (higher summer water temperatures). Consistently identified types of impacts on snow pack, stream flow, and water quality in the Columbia Basin are the following (ISAB 2007):

- Warmer temperatures will result in more precipitation falling as rain rather than snow.
- Snow pack will diminish, and the timing of stream flow will be altered.
- Peak river flows will likely increase.
- Water temperatures will continue to rise.

These changes may affect steelhead more than other salmonids because of their long rearing period in freshwater.

Changing conditions could also affect salmonid health and survival in the ocean through a variety of mechanisms, including increased ocean temperatures, increased stratification of some waters, changes in the upwelling season, shifts in the distribution of salmonids, long-term variability in winds and ocean temperatures, increased acidity, and increased atmospheric and oceanic variability (NMFS 2007, 2008a; ISAB 2007).

All other threats and conditions remaining equal, future deterioration of water quality, water quantity, and/or physical habitat can be expected to cause a reduction in the number of naturally produced adult steelhead returning to these populations across the DPS. This possibility further reinforces the importance of achieving survival improvements throughout the entire steelhead life cycle. Recent research also indicates that neighboring populations with differences in habitat may show different responses to climate changes (Crozier and Zabel 2006; Crozier et al. 2008). This research reinforces the importance of maintaining habitat diversity. Ongoing efforts to develop models of future climate effects should be considered in adaptive management.

6.4 MPG Limiting Factors

The MPG-level summaries of limiting factors are based on population-level summaries compiled from the relevant management unit plans.

6.4.1 Cascades Eastern Slope Tributaries MPG

The following are major limiting factors for the Cascades Eastern Slop Tributaries MPG:

Tributary habitat. Degraded tributary habitat is a limiting factor to a greater or lesser degree throughout the area, including degraded riparian areas, reduced LWD recruitment, altered sediment routing, low or altered stream flows, degraded water quality (especially high water temperatures), impaired floodplain connectivity/function, altered channel structure/complexity, and impaired fish passage.

Mainstem passage. Mainstem Columbia River hydro system effects are least for the Fifteenmile Creek and Klickitat River populations, which pass only one mainstem dam. The Deschutes River populations pass two mainstem dams, and the Rock Creek population passes three.

Hatchery related effects. Influence from hatchery fish could be a significant factor for this MPG because of out-of-subbasin straying onto natural spawning grounds in the Deschutes River and also because of potential effects of hatchery releases on naturally produced steelhead in the Klickitat River. The Oregon Mid-C Expert Panel considered out-of-subbasin (and out-of-DPS) hatchery strays a primary threat to genetic traits and productivity of naturally produced Deschutes river steelhead populations. Out-of-DPS hatchery strays comprised an average of 29 percent of the Eastside population and 15.2 percent of the Westside population over the past three generations. This high fraction resulted in moderate risk ratings for spawner composition for both populations.

Blocked migration to historically accessible habitat. Historically, summer steelhead had free access to most of the Deschutes watershed, including the Crooked River, Metolius River, Deschutes River upstream to Big Falls, and Whychus Creek. Summer steelhead were historically present throughout much of the Crooked River basin, with the exception of the North Fork Crooked River above Upper and Lower Falls. Steelhead were still present in the Crooked River until the mid to late 1950s, and were occasionally caught by anglers. Now the Pelton-Round Butte Hydroelectric Project (Project), constructed at river mile (RM) 100 on the mainstem Deschutes River, creates the primary barrier to anadromous fish attempting to

reach spawning and rearing areas in the upper basin. The project was completed in 1964 with upstream and downstream fish passage facilities. However, by 1966 it appeared that downstream passage through Lake Billy Chinook, the reservoir behind Round Butte Dam, could not be maintained because of poor guidance of out-migrating smolts. The last fish were passed in 1968. Currently, plans are underway to reinitiate fish passage facilities at the Pelton-Round Butte complex and reintroduce steelhead to the upper basin (details in Oregon Steelhead Recovery Plan).

Historically, summer and winter steelhead spawned in the White Salmon subbasin. Condit Dam, constructed in 1913 on the mainstem White Salmon River, blocks all anadromous fish migration to historical habitats in the upper subbasin. Condit Dam is scheduled to be removed in 2009.

Predation/competition/disease. This refers to predation, competition, and disease issues in mainstem and estuary that affect all of the Middle Columbia steelhead populations (see Section 6.3.5). In addition, the Oregon Steelhead Recovery Plan hypothesizes that the abundance of the Deschutes River Westside population may be limited by competition with a large resident population of rainbow trout.

6.4.2 John Day River MPG

The following are major limiting factors for the John Day River MPG:

Mainstem passage. These populations must pass three dams; thus, limiting factors include direct mortality of pre-smolts and smolts at John Day, The Dalles, and Bonneville dams; delayed upstream migration of returning adults; false attraction of returning adults over McNary Dam; and cumulative impact of hydropower system on mainstem and estuary habitat (see Hydro Module, NMFS 2006).

Hatchery related effects. Out-of-DPS hatchery fish straying into natural spawning areas (10 to 18 percent in the Lower Mainstem John Day) pose risks to genetic traits and productivity of naturally produced steelhead. Concern over competition for resources with wild fish and potential hybridization with natural-origin fish resulted in termination of all hatchery stocking of *O. mykiss* in the John Day River basin in 1997. Most hatchery stray recoveries occur in the Lower Mainstem John Day below the North Fork; however, strays have been observed in all populations.

Tributary habitat. For all five John Day populations, degraded floodplain and degraded channel structure (key habitat quantity and habitat diversity), altered sediment routing, water quality (temperature), and altered hydrology are limiting factors. For the Lower and Upper Mainstem and South Fork populations, passage obstructions in some of the smaller tributaries are also significant.

Predation/competition/disease. This refers to predation, competition, and disease issues in mainstem and estuary that affect all of the Middle Columbia steelhead populations.

6.4.3 Umatilla/Walla Walla MPG

The following are the major limiting factors for the Umatilla/Walla Walla MPG:

Mainstem passage. The Walla Walla and Touchet populations must pass four major dams; the Umatilla population must pass three.

Tributary habitat. For all three populations, water quality (temperature), sediment, blocked and impaired fish passage, degraded floodplain and channel structure (key habitat quantity and habitat diversity) and hydrologic alterations are limiting factors.

On the lower Umatilla River, six major irrigation diversions withdraw enough water to dewater the river in mid-summer. McKay Dam blocks fish passage to 108 miles of historically accessible habitat. Bennington Dam, east of the City of Walla Walla on Mill Creek, a tributary of the Walla Walla River, is a significant passage obstruction.

Hatchery related effects. The hatchery program on the Umatilla River uses endemic (native) stock and is not currently considered a threat to wild steelhead; however, out-of-DPS strays pose a risk to spawner composition. The hatchery program on the Walla Walla and Touchet rivers uses non-endemic stock, but an endemic stock program is under development. Non-endemic-origin hatchery fish from mitigation releases into the lower Walla Walla River have been straying into upper river natural production areas at relatively low, but increasing levels. Recent smolt releases in the program have been reduced. Future levels of straying are uncertain, and additional actions may be necessary. Currently, data are insufficient to determine whether hatchery effects are a problem for wild steelhead in the Touchet River.

Predation/competition/disease. This refers to predation, competition, and disease issues in mainstem and estuary that affect all of the Middle Columbia steelhead populations.

6.4.4 Yakima River MPG

The following are the primary limiting factors for the Yakima MPG:

Mainstem passage. As the farthest upstream populations in the DPS, the Yakima populations must pass four dams and undergo higher exposure to altered habitat and avian and piscine predators in the mainstem Columbia.

Tributary habitat. Fish habitat in the Yakima subbasin is substantially influenced by the development of irrigation systems. Limiting factors include altered hydrology (low summer flow, scouring peak flows due to degraded watershed conditions, high summer delivery flows in mainstem Yakima and Naches rivers, reduced winter and spring flows due to irrigation storage, delivery, and withdrawals); degraded riparian area and LWD recruitment; impaired fish passage (dams, culverts, seasonal push-up dams, entrainment in unscreened diversions); altered sediment routing; degraded water quality; loss of historical habitat because of blocked or impaired fish passage; degraded floodplain connectivity and function (loss of off-channel habitat, side channels and connected hyporheic zone); degraded channel structure and complexity; reduced outmigrant survival in the mainstem Yakima.

Hatchery related effects. The Yakima populations have the lowest rates of hatchery strays in the DPS, and hatchery effects are not considered a significant limiting factor.

Predation/competition/disease. Of the Middle Columbia steelhead populations, the Yakima basin populations have the longest migration through the mainstem Columbia River. They may therefore be more vulnerable to some factors such as avian and piscivorous fish predation. For example, Yakima steelhead, but not the others, are consumed by Caspian tern and double-crested cormorants nesting on islands at the mouth of the Snake River.

7. RECOVERY STRATEGY

The preceding chapters summarize recovery goals, biological criteria and threats criteria, current status assessment, the gap between current status and desired viability and risk, and the major limiting factors and threats identified for the Middle Columbia steelhead DPS. This information helps us understand what recovery would look like, but how will we get there? There is no single, easy fix.

Because of the steelhead's complex life cycle and the many changes that have taken place in its environment, the factors limiting its survival must be addressed in concert, and in an integrated way. The work needs to occur at a regional level, in terms of commitment to actions and funding, and at the local level, population by population. NMFS will continue to encourage collaboration among the many stakeholders engaged in recovery planning for the Middle Columbia steelhead DPS. What can be added at the DPS level is an overview of the contribution each population makes to the whole, the integration of Middle Columbia recovery actions with broader recovery actions in the Columbia River and its estuary, and encouragement for the regional coordination needed. Enormous investments of research, planning, regional coordination, actions, and political will are already underway. The intent for the DPS plan is to build upon, help to coordinate, and add to the ongoing efforts.

In designing a recovery strategy, we assume, as stated in the Oregon Steelhead Recovery Plan, that (1) remaining populations still retain the inherent characteristics needed to sustain healthy, harvestable levels when suitable conditions are provided; (2) declining trends can be reversed with appropriate actions; and (3) society is willing and able to implement appropriate actions in time. It is also assumed, based on the extensive scientific literature, that the relationships between physical and biological processes on land and in-river systems are predictable and can be manipulated with predictable results. It is also assumed that we know enough about the requirements of salmon and steelhead throughout their life cycle to identify what is wrong and what is needed. It is not possible, however, to predict with certainty how each watershed, stream reach, or spawning aggregate will respond to the intended management actions. The interacting systems are too complex.

If, as we believe, the decline of the Middle Columbia River steelhead DPS is caused by widespread habitat degradation, impaired mainstem and tributary passage, hatchery effects, and predation/ competition/ disease*, then* actions taken to improve, change, mitigate, reduce those factors will result in increased survival and improvements in abundance, survival, spatial structure, and diversity. Chapter 9 presents the best available estimate of the probable results of implementing the proposed recovery actions, but this reality must be continuously checked. Regional coordination, research, monitoring, evaluation, and adaptive management are essential. The results of these actions must be monitored, evaluated, and communicated to managers to enable them to make informed decisions to continue or change their strategy.

This chapter begins with a review of the overall goal for DPS viability, the ICTRT's view of the DPS recovery scenario, and the recommendations for action in NMFS' 2006 listing decision. We then build MPG-level strategies from the population information in the

management unit plans. The DPS-level recovery strategy is a synthesis of all of this information, focused on the DPS-wide or basin-wide issues.

7.1 DPS Recovery Scenario

NMFS' overall goal for DPS viability, as formulated by the ICTRT and described in Chapter 3 of this plan, is to have all four extant MPGs at viable (low risk) status, with representation of all the major life history strategies present historically, and with the abundance, productivity, spatial structure and diversity attributes required for long-term persistence.

The ICTRT's current status assessment for the Middle Columbia steelhead DPS and the gaps analysis show that for this DPS, the outlook is optimistic. One population, North Fork John Day, is currently at very low risk or "highly viable." Two populations are currently viable (Deschutes Eastside, Fifteenmile); eleven are at moderate risk, with good prospects for improving. However, the three large populations at high risk (Deschutes Westside, Naches, and Upper Yakima), are important to DPS viability. As a minimum, Deschutes Westside and one of the two large Yakima populations should also reach viable status, with the other large Yakima population at least reaching "maintained" status. These present significant, though not insuperable, challenges. Figure 7-1 illustrates the ICTRT's view of the recovery scenario (see Chapter 3) for the Middle Columbia steelhead DPS. The ICTRT emphasizes that in the near term it is important to improve survival for all populations.

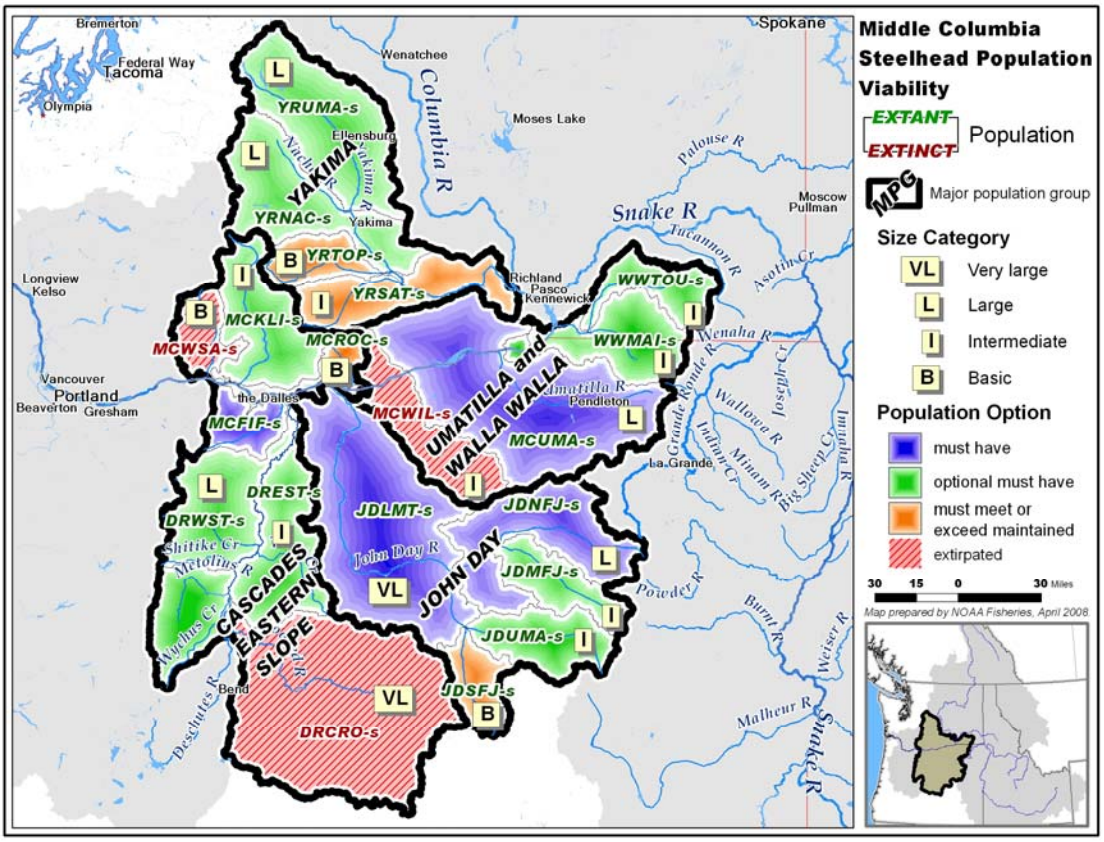


Figure 7-1. Middle Columbia steelhead DPS showing ICTRT recovery scenario

7.2 NMFS 2006 Listing Decision Recommendations

In both NMFS' 2004 proposed listing decision (69FR 33165) and its 2006 final listing decision (71 FR 834), NMFS listed 11 "conservation measures and commitments that if implemented might substantially address key limiting factors, ensure the viability over the long-term, and likely bring Middle Columbia River steelhead to the point where the protections of the ESA are no longer necessary," as follows:

(1) Continued funding by the Bonneville Power Administration (BPA) of DPS-wide riparian zone and instream habitat restoration efforts, consistent with its Fish and Wildlife Program's portion of the subbasin and recovery plans being developed;

(2) Adherence by the BLM to best management practices for grazing, mining, and recreational activities DPS-wide;

(3) Adherence by the U.S. Forest Service to best management practices for grazing, forestry, and mining activities DPS-wide;

(4) Continued conservative fisheries management by the Washington Department of Fish and Wildlife within the range of this DPS, and development and implementation of a long-term approach that balances natural and hatchery production across the DPS;

(5) Continued conservative fisheries management by the Oregon Department of Fish and Wildlife (particularly in the John Day River subbasin), development and implementation of management approaches to reduce the straying of out-of-basin stocks into Deschutes and John Day spawning areas, and development and implementation of a long-term approach that balances natural and hatchery production across the DPS;

(6) Improved passage and flow management by the U.S. Bureau of Reclamation below all its facilities in the Yakima River and the Umatilla River subbasins, provision of fish passage into significant tributaries, and provision of passage over at least two of its storage dams in the Yakima Basin[36];

(7) Provision for passage in the Deschutes River subbasin above the Pelton/Round Butte complex by the Federal Energy Regulatory Commission (FERC); restoration of downstream water temperature regime to historical levels, and provision for upstream/downstream habitat enhancement and restoration;

[36] The conservation measures in NOAA's 2006 listing decision specifically identify the need for passage at two or more of the storage dams in the Yakima Basin. The Yakima Steelhead Recovery Plan strongly recommends the provision of passage at the storage dams, but notes that the geographic distribution criteria detailed in the plan provide for combinations of spawning areas that would meet de-listing and short-term recovery thresholds without provision of access above the storage dams (See Appendix E, Section 4.3.7)

(8) Improvement of fish passage, screening, and flow management in the Walla Walla River subbasin by the U.S. Army Corps of Engineers, and alteration of the flood operating rule for Mill Creek, or alternatively screening the diversion into Bennington Lake;

(9) Continued conservative hatchery and harvest management by the Yakama Nation and adherence to best land management practices;

(10) Continued conservative hatchery and harvest management by the Confederated Tribes of the Umatilla Reservation; and

(11) Continued adherence to best land management practices by the Confederated Tribes of the Warm Springs Reservation in the Deschutes River subbasin.

These recommendations call upon Federal, state, and tribal entities to do their best to manage land, hydropower, hatchery and harvest activities in a manner that would support steelhead recovery. NMFS reaffirms these recommendations. This recovery plan encompasses and moves beyond them in organizing the considerable contributions of science and consensus building contained in the management unit recovery plans.

7.3 Summary of Recovery Strategies for the MPGs

The following sections summarize the recovery strategy for each MPG. Tables 7-1 through 7-4 show more detail from the management unit plans. The tables link the strategies with the limiting factors addressed.

7.3.1 Cascades Eastern Slope Tributaries MPG

Population	ICTRT Risk Status
Fifteenmile Creek	Viable
Deschutes Eastside	Viable
Klickitat	(provisional) Moderate risk – insufficient data, hatchery influence
Rock Creek	(provisional) High risk – insufficient data
Deschutes Westside	High risk
White Salmon	Functionally extirpated
Crooked River	Extinct

Two populations in this MPG meet the criteria for viable status (Fifteenmile Creek and Deschutes Eastside); one (Klickitat) is assigned a provisional moderate risk ("maintained" status) based on insufficient abundance/productivity data and an unknown degree of diversity risk from hatchery influence; one (Rock Creek) is assigned a provisional high risk status because of lack of data; one (Deschutes Westside) is at high risk for abundance/productivity and moderate risk for spatial structure/diversity, primarily because of blocked passage to a large amount of historically accessible habitat. Two populations in the MPG are extirpated (White Salmon and Crooked River); the Crooked River population was historically very large.

Gap: The median survival gap (assuming recent ocean and base hydrosystem conditions and 5 percent risk) for the Eastern Cascades MPG is 0.21 (meaning that a 21 percent increase in average life-cycle survival is required to achieve 5 percent risk in a 100-year time period). The gap ranges from –0.34 (Deschutes Eastside) (no gap) to 0.78 (Deschutes Westside) (needs 78 percent improvement). There was not enough information to estimate gaps for the Klickitat or Rock Creek populations.

Recovery Scenario: For the Eastern Cascades Slope Tributaries MPG to be considered viable based on the currently extant populations, the Klickitat, Fifteenmile, and both the Deschutes Eastwide and Westside populations should reach viable status, with one highly viable. The Rock Creek population should reach "maintained" status (25 percent or less risk level). MPG viability could be further bolstered if reintroduction of steelhead into the Crooked River succeeds and if the White Salmon population is successfully reintroduced to its historical habitat.

Key actions proposed (more detail in Table 7-1):

- Protect, improve, and increase freshwater habitat for steelhead production. Improvements to freshwater habitat should be targeted to address specific limiting factors in specific areas as described in the Oregon Steelhead Recovery Plan and the Washington Gorge plans.

- Reduce straying of out-of-DPS hatchery fish onto natural spawning grounds within the Deschutes subbasin.
- Restore historical passage to the upper Deschutes subbasin including the Westside tributaries and Crooked River above Pelton Round Butte dam complex and the White Salmon River above Condit Dam.
- Improve survival in mainstem and estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008).
- Improve hatchery management to minimize impacts from hatchery releases on naturally produced steelhead within the Deschutes West and East and Klickitat subbbasins.
- Fill data gaps for better assessment of Klickitat and Rock Creek steelhead populations.
- Coordinate between scientists, planners, and implementers of recovery actions on both sides of the river for sequencing of recovery actions and monitoring for adaptive management.

Summary of MPG Recovery Strategy: The proposed actions for the five extant populations in the Eastern Cascades MPG are based on restoring important tributary habitat functions in areas that likely supported substantial steelhead production. The particular actions proposed for each population are predicated upon restoring natural conditions supporting summer rearing and overwintering in high potential reaches. For Eastern Cascades populations, restoring degraded instream channel structure and the associated riparian habitats is a common element. For several populations, restoring sufficient flow, addressing high summer water temperatures, and other water quality issues are also key components. Quantitative modeling indicates that achieving the targeted levels of habitat improvement will translate into increases in both juvenile production capacity and survival rates through the key summer and winter juvenile rearing periods. Restoring access to tributaries with substantial amounts of high quality habitat is also a high priority across populations. Current and future increases in steelhead production from tributary habitats will be further bolstered by actions aimed at reducing mortalities during juvenile and adult migrations to and from the ocean.

The specific tributary habitat strategy for each population builds out from good habitat, targeting opportunities where there is substantial habitat potential. For the Fifteenmile Creek, Deschutes (eastside), Deschutes (Westside) and Rock Creek populations, restoring stream structure, riparian habitat, and water quality (temperature, sediments, etc.) in the lower reaches of major tributaries and the associated population mainstems are identified as high priorities. In the Klickitat, recent passage improvements at Castille Falls have reduced impediments to steelhead access into a substantial amount of habitat in the upper Klickitat River. Restoring stream channel structure and diversity and addressing tributary access problems in the Upper Klickitat is highlighted in the plan. Unique to the Westside Deschutes River population is a major effort to restore upstream and downstream passage at the Pelton/Round Butte Complex. This passage restoration combined with reintroductions using hatchery fish is designed to reestablish natural production in the blocked areas in the Westside population and in the extirpated Crooked River population.

The recovery strategy for the two Deschutes River populations involves reducing the impacts and risks associated with chronically high levels of non-local stray hatchery spawners. While direct estimates of impacts on these particular populations are not available, steelhead field studies in nearby drainages and modeling of the proposed actions indicate that natural productivity may be significantly impaired, especially given the abundance of strays. The current steelhead hatchery program in the Klickitat River is intended to be a segregated program; an important objective is to minimize spawning interactions with natural-origin spawners. The Klickitat River strategy includes evaluating the performance of the current programs in the Klickitat (steelhead, chinook and coho), adjusting to complement natural recovery efforts, and considering the use of artificial production in restoring production above Castille Falls.

An important element across all of the Middle Columbia steelhead populations is to continue to manage harvest in a manner that supports recovery efforts. Middle Columbia steelhead runs are subject to harvest in mainstem Columbia River fisheries and in hatchery-directed tributary fisheries. Fisheries in each of those geographic areas are currently managed under impact limits for natural-origin steelhead and all recreational fisheries prohibit retention of natural-origin fish.

Results of modeling management action effectiveness indicate that for most of the populations in the Eastern Cascades Slope Tributaries MPG, most of the productivity and capacity benefits from the proposed recovery actions will result from those focused on tributary habitat.

Table 7-1 Recovery Strategies and Actions for the Cascades Eastern Slope Tributaries MPG

CASCADES EASTERN SLOPE TRIBUTARIES MPG				
Strategies (Not necessarily in order)	**Populations Affected and Addressed**	**Key Actions**	**VSP Parameters Addressed**	**Limiting Factors Addressed**
Tributary Habitat				
Protect and conserve natural ecological processes that support the viability of populations and their primary life history strategies throughout their life cycle.	All populations in MPG	• Protect highest quality habitats through acquisition and conservation. • Adopt and manage Cooperative Agreements. • Conserve rare and unique functioning habitats. • Consistently apply Best Management Practices and existing laws to protect and conserve natural ecological processes.	All Parameters	Degradation of tributary habitat-forming processes and functions (loss of channel structure, floodplain connectivity, riparian vegetation and LWD recruitment)
Restore passage and connectivity to habitats blocked or impaired by artificial barriers	Deschutes Westside Deschutes Eastside Fifteenmile Creek White Salmon River Klickitat River Rock Creek	• Provide passage at Condit Dam. • Provide passage at Pelton-Round Butte Complex (PRBC). • Provide passage at Pine Creek confluence with Columbia River. • Improve steelhead passage at Lyle Falls Fishway. • Remove or replace barriers blocking or impairing passage including dams, dikes, road culverts and irrigation structures. • Provide screening at 100% of irrigation diversions. • Replace screens that do not meet criteria.	Abundance, Productivity, Spatial Structure	Loss of historical habitat because of blocked or impaired fish passage (dams, culverts, seasonal push-up dams, unscreened diversions)
Restore floodplain connectivity and function	Fifteenmile Creek Deschutes Westside Deschutes Eastside White Salmon River Klickitat River Rock Creek Major Creek	• Reconnect side channels and off-channel habitats to stream channels. • Restore wet meadows. • Reconnect floodplain to channel. • Relocate or improve floodplain infrastructure and roads.	Abundance, Productivity, Spatial Structure	Degraded floodplain connectivity and function (loss of off-channel habitat, side channels and connected hyporheic zone)
Restore channel structure and complexity	Fifteenmile Creek Deschutes Westside Deschutes Eastside White Salmon River Klickitat River Rock Creek Major Creek	• Place stable wood and other large organic debris in streambeds. • Stabilize streambanks. • Restore natural channel form.	Abundance, Productivity	Degraded channel structure and complexity (loss of spawning and rearing habitat, LWD, pools)
Restore riparian condition and LWD recruitment	Fifteenmile Creek Deschutes Westside Deschutes Eastside White Salmon River Klickitat River Rock Creek	• Restore natural riparian vegetative communities. • Develop grazing strategies that promote riparian recovery.	Abundance, Productivity	Degraded riparian condition (native riparian vegetative communities, LWD recruitment)

CASCADES EASTERN SLOPE TRIBUTARIES MPG				
Strategies (Not necessarily in order)	**Populations Affected and Addressed**	**Key Actions**	**VSP Parameters Addressed**	**Limiting Factors Addressed**
	Major Creek			
Restore altered hydrograph to provide appropriate flows during critical periods	Fifteenmile Creek Deschutes Westside Deschutes Eastside White Salmon River Klickitat River Rock Creek	• Implement agricultural water conservation measures. • Improve irrigation conveyance and efficiency. • Lease or acquire water rights and convert to instream. • Restore natural functions and processes through actions identified in strategies above. • Employ BMPs for forest, agriculture and grazing practices and road management. • Protect and/or rehabilitate springs	Abundance, Productivity	Altered hydrology (low summer flow, scouring peak flows due to degraded watershed conditions and/or streamflow alterations and withdrawals for irrigation and other uses)
Improve degraded water quality	Fifteenmile Creek Deschutes Westside Deschutes Eastside White Salmon River Klickitat River Rock Creek	• Reduce chemical pollution inputs. • Restore natural functions and processes through actions identified in strategies above. • Employ BMPs for forest, agriculture and grazing practices and road management. • Upgrade or remove problem forest roads • Conduct pathogen sampling and monitoring Construct water and sediment control basins	Abundance, Productivity	Degraded water quality (abnormal temperatures or fine sediment, nutrients from runoff, pesticides and other chemicals, and/or degraded because of water withdrawals that reduce natural streamflows)
Harvest				
Manage to maintain current low impact fisheries and reduce harvest-related adverse effects in those fisheries that have significant impacts.	All populations in MPG	• Maintain current management regulations for low impact fisheries and adjust tributary harvest regulations in areas where harvest significantly impacts steelhead viability. • Monitor and evaluate effects of tributary harvest.	Abundance, Productivity	Not a primary limiting factor.
Use harvest to reduce abundance and proportion of stray hatchery spawners.	Deschutes Westside Deschutes Eastside	Develop educational outreach program to promote retention of hatchery fish in selective recreational fisheries to reduce the number of out-of-basin hatchery strays.	Abundance, Productivity, Diversity	Straying of Out-of-DPS hatchery fish into natural spawning areas.
Reduce illegal harvest on ESA- listed species	Klickitat River	• Eliminate illegal harvest by enforcing sport and Tribal regulations	Abundance, Productivity	Not a primary limiting factor.
Provide better educational opportunities at the COE Park to preventing accidental catch of steelhead.	Rock Creek	• Increase outreach efforts to reduce the number of steelhead caught in recreational fisheries near the mouth of Rock Creek.	Abundance, Productivity	Not a primary limiting factor.
Hatchery				
Determine origin of hatchery strays and increase ability to recognize hatchery-origin fish.	Potential risk for all populations in MPG. Currently a significant	NOTE: The following measures are recommended in one or more management unit plan but have not been agreed upon by all co-managers.	Diversity	Straying of Out-of-DPS hatchery fish into natural spawning areas.

CASCADES EASTERN SLOPE TRIBUTARIES MPG				
Strategies (Not necessarily in order)	**Populations Affected and Addressed**	**Key Actions**	**VSP Parameters Addressed**	**Limiting Factors Addressed**
	risk to Deschutes Eastside and Deschutes Westside populations.	- Implement representative coded-wire-tagging (CWT) program so that all hatchery stocks have adequate CWT groups released annually. - Mark all hatchery steelhead releases in Columbia River Basin with, at a minimum, an adipose fin-clip. (An exception may be the proposed Klickitat hatchery program – a conservation hatchery program – that may use elastomer eye marking for evaluations.) - Recommend development of alternative broodstocks to reduce stray rates for programs that contribute significantly to stray problem. - Reduce proportion of Snake River hatchery smolts transported from Lower Granite and Little Goose dams.		
Reduce uncertainty in abundance and proportion of hatchery strays spawning naturally	Fifteenmile Creek Deschutes Eastside Klickitat River, Rock Creek	• Increase efforts to monitor incidence of hatchery fish on spawning grounds through additional stream surveys and other methods.	Diversity	Out-of-DPS and Inside-DPS hatchery strays in tributary natural spawning grounds
Reduce abundance and proportion of stray hatchery fish that spawn naturally.	Deschutes Eastside Deschutes Westside	• Construct, improve trapping facilities and expand operations	Abundance, Productivity, Diversity	Out-of-DPS and Inside-DPS hatchery strays in tributaries
Reduce genetic risks associated with Round Butte Hatchery Program.	Deschutes Westside	• Investigate opportunities and risks associated with incorporating naturally produced Deschutes River summer steelhead into Round Butte Hatchery (RBH) broodstock.	Diversity	Not a primary limiting factor
Restore natural production into historically utilized habitats, including blocked areas above Pelton-Round Butte Complex (Deschutes), Condit Dam (White Salmon) and Castile Falls (Klickitat)	Deschutes Westside Klickitat River White Salmon River	• Develop plan for steelhead reintroductions into historical habitat when passage is restored. • Re-establish natural production in MaSAs and some minor spawning areas.	All Parameters	Not a primary limiting factor
Review effect of current hatchery practices and releases.	White Salmon River Klickitat River	• Review potential impact of Skamania stock steelhead on naturally producing steelhead.	Abundance, roductivity, diversity	Not a primary limiting factor

7.3.2 John Day River MPG

Population	ICTRT Risk Status
North Fork John Day	Highly viable
Upper Mainstem John Day	Moderate risk
Lower Mainstem John Day	Moderate risk
Middle Fork John Day	Moderate risk
South Fork John Day	Moderate risk

This MPG does not meet viability criteria despite the fact that one of its populations, the North Fork John Day, is the only steelhead population in the Middle Columbia DPS classified as highly viable. The other four populations in the MPG are at maintained status. Both the Upper and Lower Mainstem John Day populations have moderate risk for diversity because of out-of-DPS hatchery strays. The Middle Fork population has moderate risk because of low abundance. The South Fork population has moderate risk for abundance and productivity, and there is also some uncertainty concerning the proportion of hatchery strays spawning.

Gap: The median survival gap for the John Day MPG is 0.09, ranging from –0.49 (North Fork) (no gap) to 0.34 (South Fork) (needs 34 percent improvement in average survival over the life cycle).

Recovery Scenario: For the John Day River MPG to reach viable status, the Lower Mainstem John Day River, North Fork John Day River, and either the Middle Fork John Day River or Upper Mainstem John Day River populations should achieve viable status, with one highly viable.

Key Actions proposed (more detail in Table 7-2):

- Protect and improve freshwater habitat conditions and connectivity for steelhead production. Improvements to freshwater habitat should be targeted to address specific factors in specific areas as described in the Oregon Steelhead Recovery Plan.
- Improve hatchery management to reduce straying from out-of-DPS hatchery fish onto natural spawning grounds within the John Day subbasin.
- Improve survival in mainstem and estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008).

The Oregon Steelhead Recovery Plan identifies priority areas and actions for each population based on relative importance in meeting local and regional recovery objectives, and envisions local groups using the individual population action tables for development of specific implementation plans.

Summary of MPG Recovery Strategy: John Day River steelhead populations have been affected by changes across all the types of habitat they use in their complex life histories and across all their life stages. Of particular importance is the loss of rearing habitat quality and floodplain channel connectivity in the lower sections of major tributaries. Poor conditions in the downstream migration corridors affect both outmigrating juveniles and returning adults.

For some populations, increased sedimentation and altered flow regimes have resulted in increased mortality during incubation and early rearing. Higher summer water temperatures have significantly reduced the available rearing habitat.

Recovery strategies for John Day steelhead are designed to improve conditions across the range of habitats used for spawning, rearing, and migration. Actions projected to contribute the most would restore or maintain rearing habitat complexity and address sediment and temperature problems, especially in reaches that are adjacent to high quality habitats. Restoration of the associated riparian habitats will also contribute to sustaining natural stream functions. These actions will reduce sediment, restore a more normal hydrograph, and reduce water temperature. In addition, there are a significant number of actions to improve passage and connectivity of habitats for both juvenile and adult life stages.

The effect of improved tributary habitat will be enhanced if, in addition, migration conditions in the mainstem Columbia River and estuary are improved, fewer outside-origin hatchery fish spawn within the basin, and harvest is managed so that a high proportion of the increased numbers of steelhead return to spawn.

Table 7-2 Recovery Strategies and Actions for the John Day River MPG

JOHN DAY RIVER MPG				
Strategies	**Populations Affected and Addressed**	**Key Actions**	**VSP Parameters Addressed**	**Primary Limiting Factors Addressed**
Tributary Habitat				
Protect and conserve natural ecological processes that support the viability of populations and their primary life history strategies throughout their life cycle.	All populations in MPG	• Protect highest quality habitats through acquisition and conservation. • Adopt and manage Cooperative Agreements. • Conserve rare and unique functioning habitats. • Consistently apply Best Management Practices and existing laws to protect and conserve natural ecological processes.	All Parameters	Degradation of tributary habitat-forming processes and functions (loss of channel structure, floodplain connectivity, riparian vegetation and LWD recruitment)
Restore passage and connectivity to habitats blocked or impaired by artificial barriers	All populations in MPG	• Remove or minimize use of push-up dams • Remove or replace barriers blocking passage • Provide screening at 100% of irrigation diversions. • Replace screens that do not meet criteria. • Improve passage at culverts on forest land	Abundance, Productivity, Spatial Structure	Loss of historical habitat because of blocked or impaired fish passage (push-up dams, culverts, unscreened diversions)
Restore floodplain connectivity and function	Lower Main John Day South Fork John Day Upper Main John Day	• Reconnect side channels and off-channel habitats to stream channels. • Restore wet meadows. • Reconnect floodplain to channel.	Abundance, Productivity, Spatial Structure	Degraded floodplain connectivity and function (loss of off-channel habitat, side channels and connected hyporheic zone)
Restore channel structure and complexity	All populations in MPG	• Place stable wood and other large organic debris in streambeds. • Stabilize streambanks. • Restore natural channel form.	Abundance, Productivity	Degraded channel structure and complexity (loss of spawning and rearing habitat, LWD, pools)
Restore riparian condition and LWD recruitment	All populations in MPG	• Restore natural riparian vegetative communities. • Develop grazing strategies that promote riparian recovery. • Install/maintain fencing	Abundance, Productivity	Degraded riparian condition (native riparian vegetative communities, LWD recruitment)
Restore altered hydrograph to provide appropriate flows during critical periods	All populations in MPG	• Implement agricultural water conservation measures. • Improve irrigation conveyance and efficiency. • Lease or acquire water rights and convert to instream. • Restore natural functions and processes through actions identified in strategies above • Employ BMPs to forest, agriculture and grazing practices and to road management	Abundance, Productivity	Altered hydrology (low summer flow, scouring peak flows due to degraded watershed conditions and/or streamflow alterations and withdrawals for irrigation and other uses.)
Improve degraded water quality	All populations in MPG	• Reduce chemical pollution inputs. • Reduce discharge from mining and dredging areas.	Abundance, Productivity	Degraded water quality (abnormal temperatures or fine sediment, nutrients from runoff, pesticides and other chemicals, and/or degraded because of water

JOHN DAY RIVER MPG				
Strategies	**Populations Affected and Addressed**	**Key Actions**	**VSP Parameters Addressed**	**Primary Limiting Factors Addressed**
		• Restore natural functions and processes through actions identified in strategies above • Employ BMPs to forest, agriculture and grazing practices and to road management		withdrawals that reduce natural streamflows)
Harvest				
Manage to maintain current low impact fisheries and reduce harvest-related adverse effects in those fisheries that have significant impacts.	All populations in MPG	• Maintain current low impact fisheries and reduce harvest-related adverse effects in those fisheries that have significant impacts.	Abundance, Productivity	Not a primary limiting factor
Use harvest to reduce abundance and proportion of stray hatchery spawners.	All populations in MPG	• Develop educational outreach program to promote retention of hatchery fish in selective recreational fisheries to reduce the number of out-of-basin hatchery strays.	Abundance, Productivity, Diversity	Straying of out-of-basin hatchery fish into natural spawning areas
Reduce catch and release mortality on natural-origin fish	All populations in MPG	• Promote voluntary curtailment of fishing at higher water temperatures (above 21°C) to reduce hook-and-release mortality	Abundance, Productivity	Not a primary limiting factor
Improve quality of harvest and natural-origin fish data.	All populations in MPG	• Expand the creel surveys to monitor fisheries effort and catch.	Abundance, Productivity	Not a primary limiting factor
Hatchery				
Reduce uncertainty of origin of hatchery strays and increase ability to recognize hatchery-origin fish.	Potential risk for all populations in MPG. Currently a primary risk to Lower John Day population.	NOTE: The following measures are recommended in one or more management unit plan but have not been agreed upon by all co-managers. - Implement representative coded-wire-tagging (CWT) program so all hatchery stocks have adequate CWT groups released annually. - Mark all hatchery steelhead releases in Columbia River Basin with, at a minimum, an adipose fin-clip. - Recommend development of alternative broodstocks to reduce stray rates for programs that contribute significantly to stray problem. - Reduce proportion of Snake River hatchery smolts that are transported from Lower Granite and Little Goose dams.	Diversity	Straying of Out-of-DPS hatchery fish into natural spawning areas.
Reduce uncertainty in abundance and proportion of hatchery strays spawning naturally	Potential risk for all populations in MPG. Currently a primary risk to Lower John Day population.	• Increase efforts to monitor incidence of hatchery fish on spawning grounds through additional stream surveys and other methods.	Diversity	Out-of-DPS and Inside-DPS hatchery strays in tributary natural spawning grounds

7.3.3 Yakima River MPG

Population	ICTRT Risk Status
Upper Yakima River	High Risk
Naches River	High Risk
Satus Creek	Moderate Risk
Toppenish Creek	Moderate Risk

The Yakima MPG is currently rated at High Risk. The two largest populations in the drainage (Naches and Upper Yakima) are rated at High Risk; the Satus Creek and Toppenish Creek populations are rated as Maintained.

Gap: The median survival gap (assuming recent ocean and base hydrosystem conditions) for the Yakima MPG is 0.77 (needs 77 percent improvement in average survival over the life cycle), ranging from 0.22 (Satus—tributary only) to 1.15 (Upper Yakima). This is the highest median survival gap of the four MPGs that make up the Middle Columbia River DPS.

Recovery Scenario: For the Yakima River MPG to achieve viable status, two populations should be rated as viable, including at least one of the two classified as Large - the Naches River and the Upper Yakima River. The remaining two populations should, at a minimum, meet the ICTRT's Maintained criteria.

Key actions proposed (more detail in Table 7-3):

- Protect and enhance habitat in key tributary watersheds in the Yakima Basin
- Restore passage to blocked areas in the Naches and Upper Yakima population areas,
- Alter irrigation delivery and storage operations in the Yakima Basin to improve flow conditions for Middle Columbia steelhead and use managed high flows to maintain floodplain habitat.
- Improve channel and floodplain function and reduce predation through the mainstem Yakima and Naches Rivers.
- Improve survival in the mainstem Columbia and its estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008)

Summary of Recovery Strategy:

Tributary and mainstem habitats for steelhead in the Yakima basin have been substantially altered from historical conditions. High quality rearing habitat has been substantially reduced or rendered inaccessible. Especially in the Naches and Upper Yakima mainstem reaches, degraded conditions such as flow reductions, increased temperatures, and altered stream structure have reduced survival and the expression of life history diversity.

Recovery actions proposed to benefit Yakima River steelhead populations are aimed at improving conditions across the freshwater habitats the fish use in all life stages – from incubation and rearing to juvenile and adult migration – especially in the Yakima River mainstem. This has the highest potential to quickly make a difference by increasing productivity in the areas where fish now spawn and restoring the pattern of extended rearing

in the mainstem. It is also important to restore flow and temperature conditions conducive to steelhead rearing in mainstem reaches of the Naches River and the Upper Yakima, which are believed to have supported substantial production historically. Restoring anadromous access into tributaries with large amounts of relatively high quality habitat by targeting flow improvements and barrier removals is also a high priority, especially for the two large populations in the upper Yakima basin.

The Yakima River enters the Columbia upstream of four major hydroelectric dams. Actions to improve passage and migration survival in the mainstem Columbia River and the estuary will also contribute to achieving objectives for the Yakima populations. Since Yakima-origin steelhead are harvested in mainstem Columbia River fisheries primarily directed on fall Chinook, harvest management is another important component of the recovery strategy for these and all Middle Columbia steelhead populations.

Table 7-3 Recovery Strategies and Actions for the Yakima Basin MPG

YAKIMA RIVER MPG				
Highest Priority Strategies	**Populations Affected and Addressed**	**Key Types of Actions**	**VSP Parameters Addressed**	**Primary Limiting Factors Addressed**
Tributary Habitat				
Protect and conserve natural ecological processes that support the viability of populations and their primary life history strategies throughout their life cycle.	All populations in MPG: Upper Yakima Naches Toppenish Satus	• Protect highest quality habitats through long-term protection and conservation. • Adopt and manage Cooperative Agreements. • Conserve rare and unique functioning habitats. • Consistently apply BMPs and existing laws to protect and conserve natural ecological processes.	All Parameters	Degradation of tributary habitat-forming processes and functions (loss of channel structure, floodplain connectivity, riparian vegetation and LWD recruitment)
Restore passage and connectivity to habitats blocked or impaired by artificial barriers	All Populations	• Provide passage at selected Yakima and Naches River Storage Dams as feasible. • Remove or replace barriers blocking or impairing passage including dams, dikes, road culverts and irrigation structures. • Provide screening at 100% of irrigation diversions. • Replace screens that do not meet criteria.	Abundance, Productivity, Spatial Structure	Loss of historical habitat because of blocked or impaired fish passage (dams, culverts, seasonal push-up dams, unscreened diversions) Reduced survival due to delay and mortality due to entrainment in water diversions
Improve conditions for outmigrating smolts at diversion structures	Upper Yakima Lower Yakima migratory area (affects all populations)	• Improve smolt passage at Roza Dam. • Reduce mortality at Chandler, Roza and other Diversion Dams.	Abundance, Productivity	Increased travel time and decreased survival for outmigrating smolts
Restore floodplain connectivity and function	All Populations	• Reconnect side channels and off-channel habitats to stream channels. • Restore wet meadows. • Reconnect floodplain to channel. • Relocate or improve floodplain infastruct. & roads.	Abundance, Productivity, Spatial Structure	Degraded floodplain connectivity and function (loss of off-channel habitat, side channels and connected hyporheic zone)
Restore channel structure and complexity	All Populations	• Place stable wood and other large organic debris in streambanks. • Stabilize streambanks. • Restore natural channel form.	Abundance, Productivity	Degraded channel structure and complexity (loss of spawning and rearing habitat, LWD, pools)
Restore riparian condition and LWD recruitment	All Populations	• Restore natural riparian vegetative communities. • Develop grazing strategies that promote riparian recovery.	Abundance, Productivity	Degraded riparian condition (native riparian vegetative communities, LWD recruitment)
Restore altered hydrograph to provide appropriate flows during critical periods	All Populations	• Implement agricultural water conservation measures. • Improve irrigation conveyance and efficiency. Lease or acquire water rights and convert to instream. • Restore natural functions and processes through	Abundance, Productivity	Altered hydrology (low summer flow, scouring peak flows due to degraded watershed conditions, high summer delivery flows in mainstem Yakima Tieton and Naches rivers. Reduced winter and spring flows due to irrigation storage,

YAKIMA RIVER MPG				
Highest Priority Strategies	**Populations Affected and Addressed**	**Key Types of Actions**	**VSP Parameters Addressed**	**Primary Limiting Factors Addressed**
		actions identified in strategies above. • Employ BMPs to forest, agriculture and grazing practices, and to road management. • Protect and/or rehabilitate springs. • Increase irrigation storage as feasible.		delivery and withdrawals)
Improve degraded water quality	All Populations	• Reduce chemical pollution inputs. • Restore natural functions and processes through actions identified in strategies above. • Employ BMPs to forest, agriculture and grazing practices and to road management. • Upgrade or remove problem forest roads. • Conduct pathogen sampling and monitoring. • Construct water and sediment control basins.	Abundance, Productivity	Degraded water quality (abnormal temperatures or fine sediment, nutrients fro runoff, pesticides and other chemicals and/or because of water withdrawals that reduce natural streamflows.
Harvest				
Manage to maintain current low impact fisheries and reduce harvest-related adverse effects in those fisheries that have significant impacts.	All Populations	• Maintain current management regulations for low impact fisheries and adjust tributary harvest regulations in areas where harvest significantly impacts steelhead viability.	Abundance, Productivity	Not a primary limiting factor
Reduce illegal harvest on ESA-listed species	All Populations	• Ensure adequate enforcement to prevent illegal harvest of steelhead	Abundance, Productivity	Not a primary limiting factor
Hatchery				
Reduce uncertainty of origin of hatchery strays and increase ability to recognize hatchery-origin fish.	All Populations	NOTE: The following measures are recommended in one or more management unit plan but have not been agreed upon by all co-managers. - Implement representative coded-wire-tagging (CWT) program so all hatchery stocks have adequate CWT groups released annually. - Mark all hatchery steelhead release in Columbia River Basin with, at a minimum, an adipose fin-clip.	Diversity	Straying of Out-of-DPS hatchery fish into natural spawning areas.
Restore natural production into historically utilized habitats, including blocked areas in tributaries and above storage dams where passage is provided	Naches, Upper Yakima	• Develop plan for steelhead reintroductions into historical habitat when passage is restored. • Use small scale supplementation to re-establish natural production in MaSAs and some MiSAs	All Parameters	Risks related to steelhead reintroductions to historical habitat using inside-DPS hatchery fish
Promote repeat spawning of kelts	All Populations	• Use kelt reconditioning program	All Parameters	Reduced survival of kelts due to passage conditions in the Columbia and lower Yakima

7.3.4 Umatilla/Walla Walla MPG

Population	ICTRT Risk Status
Umatilla River	Moderate Risk
Walla Walla River	Moderate Risk
Touchet River	High Risk (provisional because of insufficient data)

This MPG does not meet viability criteria because all three populations have moderate risk for both abundance/productivity and spatial structure/diversity and are assigned "maintained" status. The annual abundance data series for the Touchet River steelhead population is relatively short and has several missing years; the ICTRT cautions that the Touchet's status/risk rating is provisional and should be interpreted with caution.

Gap: There was sufficient information available to estimate gaps for only two of the three populations within the Umatilla/Walla Walla MPG. Assuming base hydrosystem and recent ocean conditions, the survival gaps for the Umatilla and Walla Walla populations are 0.09 and 0.34, respectively.

Recovery Scenario: For the Umatilla/Walla Walla MPG to be viable, two populations should meet viability criteria, and one should be highly viable. The Umatilla River is the only large population, and therefore needs to be viable. Either the Walla Walla River or Touchet River population also need to be viable.

Key actions proposed (more details in Table 7-4):

- Coordinate between planners, scientists and those implementing recovery actions in Washington and Oregon for sequencing, monitoring, and adaptive management
- Protect and improve freshwater habitat conditions and access for steelhead production. Improvements to freshwater habitat should be targeted to address specific factors in specific areas as described in the Southeast Washington Plan and the Oregon Steelhead Recovery Plan.
- Improve hatchery management to reduce straying from out-of-DPS hatchery fish onto natural spawning grounds within the Umatilla/Walla Walla subbasins.
- Improve survival in mainstem and estuary through actions detailed in NMFS Estuary Module (NMFS 2007) and FCRPS Biological Opinion (NMFS 2008)

Summary of MPG Recovery Strategy: Natural steelhead production from the three populations in this MPG are projected to benefit from the combined effects of improved tributary habitats and enhanced survival through the migration corridor connecting upper tributary rearing habitats with the ocean. Tributary restoration strategies in these three populations put a high priority on building out from existing reaches of relatively good spawning and rearing habitat in the upper ends of major tributaries. The downriver tributary reaches targeted for restoration include a substantial amount of habitat projected to have historically supported steelhead production. Increased water temperatures during the summer rearing period, increased fine sediment levels, and loss of natural stream structure limit survival and capacity for summer rearing and overwintering in these reaches.

The plans summarize results of habitat assessments that document the distribution and relative magnitude of habitat degradation throughout the drainages. The projections of potential responses to the proposed habitat restoration actions were developed based upon considerations for the results of the habitat assessments in each population and past experiences with restoration efforts. Restoring juvenile rearing conditions in tributary mainstem rearing areas included as priorities in each population will increase the range of historically important life history patterns, increasing the resilience of the populations to fluctuations in environmental conditions. Action strategies are aimed at reducing temperatures and sedimentation by restoring riparian cover, natural bank conditions and flow regimes in targeted reaches.

An important element of the restoration strategy for each population in this MPG is to increase survivals during the smolt outmigration phase through improvements to the spring flow and temperature regimes in the tributary mainstems and the Columbia River. Actions proposed in the plans are designed to build upon the flow and passage improvements that have been gained in recent years. Hatchery programs designed to boost natural recovery efforts and to provide fish for harvest operate within each of the populations. The recovery plan includes strategies designed to limit long-term risks to natural production by controlling the distribution and level of hatchery contributions within each population.

Table 7-4 Recovery Strategies and Actions for the Umatilla/Walla Walla MPG

UMATILLA/WALLA WALLA MPG				
Strategies	**Populations Affected and Addressed**	**Key Actions**	**VSP Parameters Addressed**	**Primary Limiting Factors Addressed**
Tributary Habitat				
Protect and conserve natural ecological processes that support the viability of populations and their primary life history strategies throughout their life cycle.	All populations in MPG	• Protect highest quality habitats through acquisition and conservation. • Adopt and manage Cooperative Agreements. • Conserve rare and unique functioning habitats. • Consistently apply Best Management Practices and existing laws to protect and conserve natural ecological processes	All Parameters	Degradation of tributary habitat-forming processes and functions (loss of channel structure, floodplain connectivity, riparian vegetation and LWD recruitment)
Restore passage and connectivity to habitats blocked or impaired by artificial barriers	Umatilla River, Walla Walla River, Touchet River	• Remove or replace culverts and/or other passage barriers. • Construct ladders over existing dams. • Provide adequate screening at 100% of irrigation diversions. • Replace screens that do not meet criteria.	Abundance, Productivity, Spatial Structure	Loss of historical habitat because of blocked or impaired fish passage (dams, culverts, unscreened diversions)
Restore floodplain connectivity and function	Umatilla River, Walla Walla River, Touchet River	• Reconnect side channels and off-channel habitats to stream channels. • Restore wet meadows. • Reconnect floodplain to channel.	Abundance, Productivity, Spatial Structure	Degraded floodplain connectivity and function (loss of off-channel habitat, side channels and connected hyporheic zone)
Restore channel structure and complexity	Umatilla River, Walla Walla River, Touchet River	• Place stable wood and other large organic debris in streambeds. • Stabilize streambanks. • Restore natural channel form.	Abundance, Productivity	Degraded channel structure and complexity (loss of spawning and rearing habitat, LWD, pools)
Restore riparian condition and LWD recruitment	Umatilla River, Walla Walla River, Touchet River	• Restore natural riparian vegetative communities. • Develop grazing strategies that promote riparian recovery. • Install/maintain fencing	Abundance, Productivity	Degraded riparian condition (native riparian vegetative communities, LWD recruitment)
Restore altered hydrograph to provide sufficient flow during critical periods	Umatilla River, Walla Walla River, Touchet River	• Restore natural functions and processes through actions identified in strategies above. • Implement Umatilla Basin Project Phases I-III. • Implement water conservation measures. • Improve irrigation conveyance and efficiency. • Investigate feasibility of water storage and exchange	Abundance, Productivity	Altered hydrology (low summer flow, scouring peak flows due to degraded watershed condition and/or streamflow alterations and withdrawals for irrigation and other uses.)

UMATILLA/WALLA WALLA MPG				
Strategies	**Populations Affected and Addressed**	**Key Actions**	**VSP Parameters Addressed**	**Primary Limiting Factors Addressed**
		(WW). • Employ BMPs to forest, agriculture and grazing practices and to road management.		
Improve degraded water quality	Umatilla River	• Reduce chemical pollution inputs. • Reduce discharge from mining and dredging areas. • Restore natural functions and processes through actions identified in strategies above. • Employ BMPs to forest, agriculture and grazing practices and to road management.	Abundance, Productivity	Degraded water quality (abnormal temperatures or fine sediment, nutrients from runoff, pesticides and other chemicals and/or because of water withdrawals that reduce natural streamflows.)
Harvest				
Manage to maintain current low impact fisheries and reduce harvest-related adverse effects in those fisheries that have significant impacts.	Umatilla River, Walla Walla River, Touchet River	• Maintain current management regulations for low impact fisheries and adjust tributary harvest regulations in areas where harvest significantly impacts steelhead viability.	Abundance, Productivity	Not a primary limiting factor
Hatchery				
Reduce uncertainty of origin of hatchery strays and increase ability to recognize hatchery-origin fish.	Umatilla River, Walla Walla River	NOTE: The following measures are recommended in one or more management unit plan but have not been agreed upon by all co-managers. • Implement representative coded-wire-tagging (CWT) program so all hatchery steelhead stocks have adequate CWT groups released annually. • Mark all hatchery steelhead releases in Columbia River Basin with, at a minimum, an adipose fin-clip. • Recommend development of alternative broodstocks to reduce stray rates for programs that contribute significantly to stray problem. • Reduce proportion of Snake River hatchery smolts that are transported from lower Granite and Little Goose dams.	Diversity	Straying of out-of-DPS hatchery fish into natural spawning areas.
Reduce abundance and proportion of out-of-basin hatchery strays spawning naturally	Umatilla River	• Uniquely mark Umatilla Hatchery steelhead and remove out-of-basin hatchery strays at Three Mile Falls Dam.	Diversity	Out-of-basin hatchery strays in tributary natural spawning grounds.
Reduce abundance and proportion of out-of-basin hatchery strays spawning naturally	Walla Walla River	• (These actions are currently non-consensus recommendations.)	Diversity	Genetic risks from out-of-basin hatchery strays spawning naturally

UMATILLA/WALLA WALLA MPG				
Strategies	**Populations Affected and Addressed**	**Key Actions**	**VSP Parameters Addressed**	**Primary Limiting Factors Addressed**
		• Eliminate adult hatchery strays above Nursery Bridge Dam by resuming trapping operations and removing hatchery fish. • Alter release strategy of Lyons Ferry hatchery smolts released into lower Walla Walla River from direct stream to acclimated releases and implement trap and removal near acclimation site. • Develop local broodstock to replace Lyons Ferry stock for use in harvest augmentation program and to initiate a natural production supplementation program.		
Reduce abundance and proportion of out-of-basin hatchery strays spawning naturally	Touchet River	• Continue development of Endemic Touchet River summer steelhead program to replace current releases of Lyons Ferry hatchery summer steelhead smolts. • Improve adult trap at the Dayton Pons diversion dam to improve management of returning adult hatchery summer steelhead. • Install weir on Copei Creek to monitor escapement of summer steelhead and remove hatchery strays.	Diversity	Genetic risks from out-of-basin hatchery strays spawning naturally
Re-establish natural production in historically utilized habitats	Umatilla River	• Re-establish natural production in Little Butter and Butter creek drainages by outplanting adults and/or juveniles into tributaries after habitat conditions are restored.	Abundance, Productivity, Spatial Structure, Diversity	Loss of natural production in Butter Creek system.
Reduce genetic influence of hatchery fish in hatchery broodstock.	Umatilla River	• Eliminate use of hatchery produced adults in broodstock.	Diversity	Potential divergence in genetic and phenotypic traits between hatchery and natural-origin steelhead.
Reduce interactions between residual hatchery steelhead and natural steelhead.	Umatilla River	• Conduct volitional releases of steelhead smolts and remove fish that do not migrate.	Abundance, Productivity, Diversity	Risk of hatchery fish competing with and preying on natural steelhead juveniles
Reduce potential negative ecological interactions between coho salmon and natural steelhead.	Umatilla River	• Reduce number of hatchery coho released in Umatilla River and relocate releases downstream to areas not currently important for steelhead production.		Potential for coho smolts to compete with juvenile steelhead for prey resources and space.

7.4 DPS-Wide and Basin-Wide Issues

The following sections complement the MPG-level strategies in Section 7.3 by addressing all of the "Hs" – habitat, hydropower, hatcheries and harvest – at the DPS-or-larger scale, as well as governance, research, monitoring and evaluation, and adaptive management.

7.4.1 Degraded Tributary Habitat

NMFS considers actions to protect and improve habitat and fish passage in the tributaries essential to achieving recovery objectives for the Middle Columbia steelhead DPS. Unlike some other salmonid species, steelhead, which are "stream-type" salmonids, use mainstem tributary, upper tributary, and side channel habitats for spawning, juvenile rearing, and overwintering. Steelhead populations are particularly susceptible to the effects of degraded freshwater habitat because most steelhead spend one or more years in freshwater before migrating. While improving survival in the mainstem Columbia River and estuary is also an important part of DPS-wide strategy, and will benefit all salmonid populations, protecting existing high quality or good quality tributary habitat and restoring degraded habitat will specifically benefit Middle Columbia steelhead populations in the spawning and rearing life stages. Improved spawning and rearing means that more fish will reproduce, more juveniles will survive to migrate, and consequently more adults will return, even if the other factors remain as they are today.

The actions for tributary habitat include the following:

- Implementation of locally developed management unit plans to address protection and restoration of tributary habitat
- Implementation of Federal, state, and tribal programs, such as, for example, U.S. Forest Service and BLM best management practices for grazing, mining, and recreation, and EPA and tribal programs to implement TMDLs and cold water refugia, in a manner that addresses primary habitat strategies and actions at the local level.

7.4.2 Impaired Fish Passage

Problems in migratory corridors for juvenile and adult steelhead in tributaries and the mainstem Columbia River should be addressed to improve survival.

7.4.2.1 Impaired Fish Passage in Mainstem Columbia River

Although the Federal Columbia River Power System (FCRPS) is a major limiting factor for steelhead in the mainstem Columbia River, changing it is a complex process. Three U.S. government agencies – the Bonneville Power Administration (BPA), the U.S. Army Corps of Engineers (COE) and the Bureau of Reclamation (Reclamation), also called, collectively, the "Action Agencies" – collaborate to run the FCRPS, under various congressional authorities, as a coordinated system for power production and flood control. The 31 federally owned multipurpose dams on the Columbia and its tributaries that make up the FCRPS provide about 60 percent of the Northwest's hydroelectric generating capacity. The dams supply irrigation water to more than a million acres of land in Washington, Oregon, Idaho and Montana. The river is used for barge navigation from the Pacific Ocean to Lewiston, Idaho, 465 miles inland.

NMFS has statutory responsibility under the ESA to consult with the FCRPS agencies and determine whether FCRPS effects on listed species are likely to jeopardize the continued existence of the species or cause adverse modification of critical habitat. NMFS summarizes its findings in a Biological Opinion, or BiOp. On May 26, 2005, the Federal District Court, in *National Wildlife Federation, et al., vs. National Marine Fisheries Service, et al.,* issued an opinion finding fault with the NMFS 2004 FCRPS BiOp (NMFS 2004b). On October 7, 2005, the court ordered a "remand" of the BiOp, requiring NMFS and the three Federal agencies, called the Action Agencies, to engage in a collaborative process, which included input from affected States and Tribes, to develop proposed operational measures for analysis in a new biological opinion. The court's order, among other things, directed the Action Agencies to demonstrate how their proposed actions would contribute to recovery. A revised Biological Opinion was issued on May 5, 2008 (NMFS 2008) and is available at http://www.nwr.noaa.gov/Salmon-Hydropower/Columbia-Snake-Basin/Final-BOs.cfm

Current Columbia River hydropower programs and operations are the result of this and other completed or ongoing ESA section 7 consultation processes; habitat conservation plans (HCPs) pursuant to ESA section 10; FERC relicensing proceedings and other regulatory processes. In most cases, hydropower programs and operations are intended both to avoid jeopardy to listed species and to contribute to recovery.

The plan for current mainstem hydro operations, as summarized in the Hydro Module, and any further improvements for fish survival that may result from the ongoing FCRPS collaborative process, represent the hydropower recovery strategy for all listed salmonids that migrate through the mainstem Columbia River, including the Middle Columbia steelhead populations.

The Reasonable and Prudent Alternative (RPA) for the FCRPS takes a comprehensive approach to ESA protection that includes hydro, habitat, hatchery, harvest and predation measures to address the biological needs of salmon and steelhead in every life stage. The RPA is the product of the collaboration between NMFS and the Action Agencies ordered by the court. It is based on a comprehensive analysis of the salmon life cycle conducted down to the level of the populations that make up the listed species. Section 8.8 and the "Reasonable and Prudent Alternative Table" in the 2008 FCRPS Biological Opinion describe actions that should positively affect Middle Columbia River steelhead.

The current plan for operation of the FCRPS through 2018 (NMFS 2008) contains the following actions intended to address the needs for survival and recovery of ESA-listed salmon and steelhead:

- Continue adult fish passage operations that have resulted in improved survival.
- Improve juvenile fish passage: install removable spillway weirs or similar surface bypass devices at John Day and McNary dams, an extended tailrace spill wall at The Dalles Dam, and various modifications at Bonneville Dam. Passage for steelhead smolts at each of the four Lower Columbia River mainstem projects must reach 96 percent survival.
- Continue and enhance spill for juvenile fish passage.
- Continue reservoir operations and river flows to benefit spring migrating juveniles.

- Develop dry water year operations to better protect migrating juveniles

Dissenting View of State of Oregon Regarding Mainstem Operations

At the time this proposed recovery plan was being finalized, August 2008, it was the position of the State of Oregon that additional or alternative actions should be taken in mainstem operations of the FCRPS for ESA-listed salmon and steelhead. Some additional or alternative actions recommended by Oregon, while considered, were not included in NOAA's FCRPS Biological Opinion. At this time, Oregon is a plaintiff in litigation against various federal agencies, including NOAA, challenging the adequacy of the measures contained in the current FCRPS Biological Opinion. NOAA is not in agreement with Oregon regarding the need for or efficacy of Oregon's additional or alternative actions. The actions sought by Oregon include:

- Draft storage reservoirs to meet lower Columbia summer flow and velocity equivalent objectives on a seasonal and weekly basis.
- Operate reservoirs at rule curves and seek additional flow augmentation volumes from Snake River and Canadian reservoirs for spring and summer flow and velocity objectives.
- Operate lower Columbia reservoirs at minimum operating pool (MOP) during spring and summer as long as barge transport and irrigation needs are met.
- Provide spill to total dissolved gas limits of water quality waivers or biological constraints at all dams, except maximize transportation at Snake River collector projects during lowest (10th percentile) flow years.
- Implement 50/50 in-river and transportation proportions for spring and summer migrants in the Snake River, and provide spill throughout spring and summer migration periods for in-river migrants. Continue to provide spill and bypass all fish at McNary Dam at all flows.

7.4.2.2 Impaired Fish Passage in Tributaries

Actions to address fish passage in tributaries include:

- Implement locally developed management unit plans to improve fish passage.

- Implement recommendations regarding improved passage and flow management by the U.S. Bureau of Reclamation below all its facilities in the Yakima River and the Umatilla River subbasins, provision of fish passage into significant tributaries, and provision of passage over at least two of its storage dams in the Yakima Basin[37].

[37] The conservation measures in NOAA's 2006 listing decision specifically identify the need for passage at two or more of the storage dams in the Yakima Basin. The Yakima Steelhead Recovery Plan strongly recommends the provision of passage at the storage dams, but notes that the geographic distribution criteria detailed in the plan do provide for combinations of spawning areas that would meet de-listing and short-term recovery thresholds without provision of access above the storage dams (See Appendix E, Section 4.3.7)

- Implement recommendations regarding improvement of fish passage, screening, and flow management in the Walla Walla River subbasin by the U.S. Army Corps of Engineers, and alteration of the flood operating rule for Mill Creek, or alternatively screening the diversion into Bennington Lake.

- Provide passage into the upper Deschutes River above Round Butte/Pelton complex and into the White Salmon River above Condit Dam.

7.4.3 Hatcheries

Influence from hatchery fish is a limiting factor for the Middle Columbia steelhead DPS because of out-of-basin hatchery fish straying onto natural spawning grounds in the John Day Basin, Deschutes River Eastside and Westside, and the Umatilla and Walla Walla rivers, as well as potential effects of hatchery releases on naturally produced steelhead in the Klickitat subbasin. The hatchery programs in question are managed under the Mitchell Act and the *U.S. v. Oregon* process involving the fisheries co-managers and regulated by NMFS section 7 consultations.

NMFS is working with the funding agencies and hatchery operators to update and complete Hatchery and Genetic Management Plans (HGMPs) for every hatchery program in the Middle Columbia region. The HGMPs are the basis for NMFS' biological opinions on hatchery programs under sections 7 and 10 and the 4(d) rule, which all relate to incidental and direct take of listed species. The HGMPs describe each hatchery's operations and the actions taken to support recovery and minimize ecological or genetic impacts, such as straying and other forms of competition with naturally produced fish. The revised FCRPS Biological Opinion (NMFS 2008) requires the hatchery operators and the Action Agencies to submit to NMFS updated HGMPs describing site-specific applications of the "best management practices" for the hatchery programs as described in Appendices C and D of the Supplemental Comprehensive Analysis (SCA) of the Biological Opinion for those mitigation hatchery programs funded by the FCRPS Action Agencies.

Hatcheries are currently undergoing three major scientific reviews that are expected to provide important information that will be helpful in crafting specific hatchery actions that are consistent with salmon and steelhead recovery: the Mitchell Act Environmental Impact Statement (EIS), USFWS Hatchery Review, and the congressionally established Hatchery Scientific Review Group (HSRG). Collectively, these scientific reviews will be scrutinizing every anadromous fish hatchery in the Columbia Basin. The schedule for updating hatchery actions is designed to allow consideration of information expected from the hatchery reviews. The updated HGMPs for programs in the range of the Middle Columbia steelhead DPS will be submitted to NMFS by July 2009, with consultations completed by January 2010.

Oregon Steelhead Recovery Plan
The Oregon Steelhead Recovery Plan proposes increased marking of Columbia Basin hatchery steelhead with coded-wire tags, and requiring mass marking of all hatchery steelhead releases with, at a minimum, an adipose fin-clip. Regional consensus has not been reached on these strategies. NMFS realizes these are regional issues that need to be addressed.

Klickitat Plan
The Klickitat population's moderate risk rating was assigned primarily on the basis of uncertainty and lack of data, particularly with respect to the influence of hatchery fish on the wild steelhead population. The plan recommends a targeted monitoring program to determine abundance and productivity of natural spawners, determine the proportion of hatchery and wild spawners in the Klickitat subbasin, and determine the adverse effects of Skamania broodstock on the Klickitat population, if any.

The Yakama Nation is also working with NMFS, WDFW, Tribal fish and wildlife leaders, and others to develop a master plan for an integrated hatchery program for the Lower Klickitat River with the purpose of minimizing adverse impacts on the natural steelhead spawning population. The Yakama Nation also is working with NMFS, WDFW, tribal leaders and others to examine whether a conservation hatchery program could be used to accelerate recolonization of the Upper Klickitat watershed since passage has been restored at Castile Falls. The hatchery program would not occur for at least 9 years to allow for an evaluation of the natural recolonization management strategy.

Southeast Washington Plan
The Southeast Washington Plan does not propose actions related to hatcheries but notes that a hatchery strategy needs to balance risks to recovery of naturally spawning populations with achieving harvest objectives. In the Walla Walla basin, the plan says that the current segregated hatchery program could be transitioned to an integrated one using wild brood stock. For the Touchet River, the plan proposes intensified monitoring to determine whether strays from the segregated program pose an unacceptable risk to the genetic integrity of the natural population, and if so, to eliminate the segregated program. In the short-term both the integrated and segregated programs will be continued with increased monitoring of hatchery fish and removal of hatchery fish at the weir in Dayton. Based on monitoring of the impacts of the segregated program and the success of the integrated program it is anticipated that over the long-term only the integrated program would continue.

Yakima Steelhead Plan
The Yakima Steelhead Plan does not indicate hatchery related effects as a limiting factor for steelhead, and states that hatchery steelhead have not been released in the Yakima River system since 1993. However, the plan does propose evaluating the use of small-scale supplementation to restore steelhead to watersheds with good habitat conditions where steelhead are not present or severely reduced because of passage barriers that have been or are being removed. The plan also recommends maintaining and evaluating the existing kelt reconditioning program, which uses hatchery techniques to increase the rate of repeat spawning of wild steelhead adults.

7.4.4 Predation, Competition and Disease

Extensive research on predation and efforts at predator control in the Columbia Basin have been undertaken for decades. Control of piscivorous predation has focused largely on targeted sports fisheries to remove more of the predators and/or direct removal by physical or chemical means (NMFS 2008b). Altering Rice Island to prevent tern and cormorant nesting was effective in reducing avian predation in the estuary, and the current FCRPS Biological Opinion (NMFS 2008) recommends further reduction in bird habitat on East Sand Island. The Biological Opinion

also recommends development of plans to control Caspian terns and double-crested cormorants that nest in islands upstream of Bonneville Dam. COE takes various "avian deterrent actions" at the lower Snake and Columbia River dams, and will continue to do so.

The ISAB report indicates that the methods of controlling non-native piscivores have not been sufficient, and that maintaining and restoring habitat is actually the better strategy. "When native species are provided with habitat for which they are best adapted, they have an improved chance of out-competing or persisting with non-native species," the ISAB report states (ISAB 2008). NMFS, as indicated elsewhere in this chapter, supports that conclusion.

Northern Pikeminnow Management Program - A multi-year, ongoing effort funded by BPA to reduce piscivorous predation on juvenile salmon through incentives to sports fishermen to remove predator-sized northern pikeminnow. From 1991 to 1996, three fisheries (sport-reward, dam angling, and gill net) harvested approximately 1.1 million northern pikeminnows greater than or equal to 250 mm fork length. Total exploitation averaged 12 percent (range, 8.1 to 15.5 percent) for 1991 to 1996 (Section 6.2.7.1 in NMFS 2000b). The annual harvest rate has averaged approximately 12 percent in the last few years.

Other sport fisheries target smallmouth bass, channel catfish, and walleye. However, the ISAB report states that state fisheries agencies in Washington, Oregon, and Idaho have simultaneously adopted management policies that in some cases seem aimed at perpetuating or even enhancing populations of these introduced predators. The ISAB recommends that the Council urge the state agencies to relax (or eliminate) fishing regulations that may be enhancing populations of non-native species (both predators and competitors), especially those that directly or indirectly interact with juvenile and adult salmonids.

NMFS supports the recommendations in the Yakima Steelhead Plan for research and monitoring to track trends in predator populations, understand their impacts on steelhead, and develop appropriate management techniques to reduce predation.

Disease in salmonids is caused by multiple factors and probably cannot be directly addressed by recovery actions except in specific instances of known causal factors. It is more likely that nearly all of the recommended recovery actions that improve spawning, rearing, and passage conditions for steelhead and increase the survival, abundance, and productivity of naturally produced fish will result in decreasing incidence of disease.

Competition with hatchery fish: Evaluating the factors that influence or drive density dependent effects under varying freshwater conditions and ocean conditions is an important area of future research. This is dealt with in more detail in Appendix C of the 2008 FCRPS Biological Opinion (NMFS 2008).

7.4.5 Harvest

Although in general harvest is not considered a major threat for the Middle Columbia steelhead DPS, it is important to ensure that impacts from fisheries do not impede recovery, and to perform monitoring and evaluation to verify impacts and reduce existing uncertainties.

- The *U.S. v. Oregon* agreement for 2008-2018 will maintain current low impacts on Middle Columbia steelhead in the lower mainstem and treaty mainstem fisheries.
- The Fisheries Management and Evaluation Plans (FMEPs) submitted by the States of Oregon and Washington and approved by NMFS under the 4(d) rule of the ESA provide a mechanism for developing, implementing, and adjusting recreational fisheries to achieve management and conservation objectives. Under the FMEPs, recreational fisheries in the tributaries are expected to maintain the currently estimated low impacts on steelhead. Furthermore, NMFS requires the states to implement, monitor, and evaluate the effects of these plans and to report annually, including an assessment of the annual catch of natural fish, fishery mortality, the abundance of hatchery and natural fish for each tributary fishery area, and angler compliance. A comprehensive evaluation is required every five years. The continuing and additional monitoring and evaluation under the FMEPs is expected to further reduce uncertainties concerning fisheries impacts.
- Other increases in monitoring and evaluation will help to reduce uncertainties concerning fisheries impacts on steelhead:
    - Creel surveys or other methods of quantifying impacts in the more popular fisheries
    - In-basin monitoring of escapement from ocean into tributaries and onto the spawning grounds
    - Monitoring to verify the applicability of aggregate impact rates of mainstem fisheries on specific populations
- Other proposals in the management unit plans:
    - The Oregon Steelhead Recovery Plan proposes using selective fisheries to reduce the number of out-of-basin hatchery strays.
    - The Washington Gorge Management Unit plans recommend studies to determine the impacts of tributary fisheries and to determine the extent of illegal harvest, if any.

7.4.6 Estuary and Columbia River Plume

Although they pass through the estuary on their way to the ocean, juvenile steelhead tend to spend less residence time in the shallow parts of the estuary than other salmonids, and therefore the characteristics of the Columbia River plume and the deeper channels of the estuary are more important in determining their survival.

Flow changes in the estuary are primarily a result of dam operations, whereas habitat changes are a function of both hydropower operations and other, non-hydro issues, notably the construction of dikes and levees in the estuary. The main effects of flow on Middle Columbia steelhead populations are associated with changes in the plume. Thus, actions that affect the plume,

decrease exposure to toxicants, and decrease predation (especially Caspian tern predation) should improve the abundance/productivity and diversity of the Middle Columbia DPS.

NMFS' Estuary Module identifies 23 types of management actions that would improve estuary conditions for all salmonids. The following is a selection of these actions most beneficial to steelhead:

- Adjust the timing, magnitude and frequency of flows (especially spring freshets) entering the estuary and plume to provide better transport of sediments and access to habitats in the estuary, plume, and littoral cell.
- Manage pikeminnow, smallmouth bass, walleye, and channel catfish to prevent increases in abundance.
- Identify and implement actions to reduce salmonid predation by pinnipeds.
- Implement projects to redistribute part of the Caspian tern colony currently nesting on East Sand Island.
- Implement projects to reduce double-crested cormorant habitats and encourage dispersal to other locations.
- Implement pesticide and fertilizer best management practices to reduce estuary and upstream sources of toxic contaminants entering the estuary.
- Identify and reduce industrial, commercial, and public sources of pollutants.
- Monitor the estuary for contaminants and/or restore contaminated sites.
- Implement stormwater best management practices in cities and towns.

The module includes an evaluation of the "constraints" on implementation of these actions. Perhaps the most significant action would be to adjust the timing, magnitude and frequency of flows to return to a more natural hydrograph for the estuary; however, this is the least possible of the actions, given the constraints:

> Constraints on hydrosystem operations prevent the return to a natural hydrograph in the estuary. Implementation of this action would be limited by international treaties, the need for flood control, fish management objectives systemwide, and power management (NMFS 2007).

7.4.7 Coordination/Governance

Coordination of actions and information-sharing among fisheries biologists, Tribes, local governments, citizen groups, and state and Federal agencies based in both Oregon and Washington is a key component of recovery for this DPS. Benefits of coordination include:

- Dealing with shared migration areas consistently
- Developing coherent MPG-level strategies where populations are in two states (Cascades Eastern Slope MPG; Umatilla/Walla Walla MPG), or the same population is in both states (Walla Walla population)
- Promoting consistent methods for setting recovery objectives, evaluating strategies, and monitoring progress across populations, MPGs, and the DPS

This coordination is under development. The recent creation of a Middle Columbia Forum, to be convened regularly by NMFS, is intended to facilitate such collaboration between scientists and

recovery planners on both sides of the Columbia River. The Middle Columbia Forum is discussed further in Chapter 11, Implementation.

7.4.8 Research, Monitoring and Evaluation

An important part of the strategy for achieving recovery is the development of a monitoring plan that will support implementation of the recovery plan and long-term adaptive management in response to changes and trends in the data. Two keys to effective implementation are targeting actions to specific areas and monitoring the results of the actions. To achieve these goals, a scientific technical team made up of local scientists, former ICTRT members, and managers will be necessary. The monitoring plan is discussed in more detail in Chapter 10.

For each DPS-level, five-year status review, NMFS needs summarized information on each population derived from more detailed field assessments – at the least, monitoring data on abundance and productivity throughout the steelhead's range. The most efficient way to generate this information is through annual reports compiled by regional biologists. Currently, although basic data (e.g., redd surveys) are being gathered, funding and staff are lacking to turn this raw data into annual estimates of abundance/productivity in each river or stream in a timely fashion. Typically, each five-year status review starts with a time-consuming scramble to gather the information from the regional biologists and work with them to produce the metrics that are needed for the status assessment. These annual reports need to be funded, staffed, and standardized.

The Southeast Washington Plan proposes that the co-managers should be convened with NMFS and USFWS to better define the level (scale, frequency, location) of monitoring required to determine when recovery goals are achieved. The results of these conversations could be used to better define monitoring tasks and allow for the prioritization of expenditures.

7.5 Setting Priorities

Priorities for recovery actions should be guided by DPS-, MPG-, and population-level recovery criteria and best available scientific information concerning DPS status, the role of the independent populations in meeting DPS and MPG viability, limiting factors and threats, and likelihood of effectiveness of actions. Protection of existing habitat is essential. Issues of funding and local, state, or national support for implementation will also inevitably come into play.

The management unit plans all address these issues in their implementation sections. The Oregon Steelhead Recovery Plan offers detailed considerations for prioritization that are also adopted by the Washington Gorge Plans. The Southeast Washington Plan describes "strategic guidelines" for prioritization. The Yakima Steelhead Plan notes that the process of working out an implementation schedule with stakeholder participation will ultimately set the priorities.

See Chapter 11, Implementation, for discussion of the organization of ongoing technical review and support from DPS and management unit science and technical committees. Coordination and communication in the Mid-C Forum and other venues will be necessary for actions in the Columbia mainstem, estuary, and/or ocean.

7.5.1 Oregon Steelhead Recovery Plan

The Oregon Steelhead Recovery Plan offers an approach to steelhead recovery that attempts to integrate both the biological needs of the fish and the economic, political, social, and cultural context in which strategies must be implemented and actions chosen. The plan provides an overview of the links between threats and limiting factors, management strategies, and types of actions (Table 7-5). This is followed by detailed tables for each of the 10 Oregon steelhead populations, identifying specific proposed actions, locations, limiting factors and threats addressed, VSP parameters and life stages affected. The tables also include assessments of existing programs relevant to the proposed actions. The Oregon Steelhead Recovery Plan is included as Appendix 1 of this Plan.

Table 7-5. Integrated approach to address threats and factors limiting recovery of Oregon's Middle Columbia River steelhead populations.

Threats and Limiting Factors	Management Strategies	Types of Actions
All degraded habitat limiting factors	Protect and conserve natural ecological processes that support the viability of populations and their primary life history strategies throughout their life cycle.	Protect highest quality habitats through acquisition and conservation. Adopt and manage Cooperative Agreements. Conserve rare and unique functioning habitats. Consistently apply Best Management Practices and existing laws to protect and conserve natural ecological processes.
Degraded Habitat - Impaired fish passage	Restore passage and connectivity to habitats blocked or impaired by artificial barriers, and maintain unimpaired passage and connectivity	Remove or replace barriers blocking passage such as dams, road culverts and irrigation structures. Provide screening at 100% of irrigation diversions. Replace screens that do not meet criteria.
Degraded habitat - floodplain connectivity and function	Restore floodplain connectivity and function, and maintain unimpaired floodplain connectivity and function	Reconnect side channels and off-channel habitats to stream channels. Restore wet meadows. Reconnect floodplain to channel.
Degraded habitat - channel structure and complexity	Restore channel structure and complexity, and maintain unimpaired structure and complexity	Place stable wood and other large organic debris in streambeds. Stabilize streambanks. Restore natural channel form.
Degraded habitat - riparian area and LWD recruitment	Restore riparian condition and LWD recruitment, and maintain unimpaired conditions	Restore natural riparian vegetative communities. Develop grazing strategies that promote riparian recovery.
Degraded habitat - altered hydrology	Restore altered hydrograph to provide sufficient flow during critical periods	Implement agricultural water conservation measures. Improve irrigation conveyance and efficiency. Lease or acquire water rights and convert to instream.
Degraded habitat - water quality	Improve degraded water quality and maintain unimpaired water quality	Reduce chemical pollution inputs. Apply BMPs to animal feeding operations. Restore natural functions and processes through actions identified in strategies 1,3,4,5,8
Degraded habitat - altered sediment routing	Restore degraded upland processes to minimize unnatural rates of erosion and runoff, and maintain unimpaired natural upland processes	Achieve 95% conversion to no till farming. Upgrade or remove problem forest roads. Restore native upland plant communities. Employ BMPs to forest practices, livestock grazing, road management and agricultural practices.

Threats and Limiting Factors	Management Strategies	Types of Actions
Degraded habitat - estuarine and Nearshore Marine	Restore degraded estuarine and nearshore habitat, and maintain unimpaired conditions	Protect/restore riparian areas Remove pile dikes Protect remaining high quality off-channel habitat Breach or lower dikes and levees Identify and reduce sources of pollutants Monitor and restore contaminated sites
Mainstem Columbia River hydro system	Improve salmonid migration and habitats, and reduce predation on and competition between salmonids in the mainstem Columbia River.	Adjust the timing, magnitude, and frequency of flows Mitigate/reduce reservoir heating Continue adult fish passage operations Improve juvenile fish passage Continue and enhance spill for juvenile fish passage Modify fish transportation to improve juvenile survival
Hatchery related adverse effects	Reduce hatchery related genetic and ecological effects on natural populations of Middle Columbia steelhead	Increase marking of Col. Basin hatchery steelhead with coded-wire tags. Require mass marking of all hatchery steelhead releases with, at a minimum, an adipose fin-clip. Increase efforts to monitor incidence of hatchery fish on spawning grounds. Develop plan for steelhead reintroduction into historical habitat when passage is restored. Eliminate the use of hatchery produced adults in the broodstock Construct trapping facilities
Harvest-related adverse effects	Manage fisheries to reduce harvest-related adverse effects	Use selective recreational fisheries to reduce the number of out-of-basin hatchery strays. Call for a voluntary curtailment of fishing at higher water temperatures (above 21°C) as a measure to reduce hook-and-release mortality Expand the creel surveys to monitor fisheries effort and catch
Predation, competition, disease	Reduce predation, competition and disease	Reduce predation by pinnipeds Redistribute Caspian terns Redistribute cormorants

The Oregon Steelhead Recovery Plan's recommendation for setting priorities is a list of "considerations," based on key principles derived from conservation biology and ecosystem management.

The principles for sound salmon recovery efforts:

1) *Set aside or protect the highest quality habitat.*
2) *Do not let habitat conditions degrade further.*
3) *Maintain or restore critical ecological processes.*
4) *Develop goals and objectives based on deep understanding of ecological properties of the system.*
5) *Evolutionary processes must be conserved or restored.*
6) *Management must be adaptive and minimally intrusive.*

The considerations for prioritizing actions:

We consider actions that achieve the following to be highest priority:

- *Actions that provide long-term protection of habitat conditions and conservation of natural ecological processes that support the viability of priority extant populations and their primary life history strategies throughout their entire life cycle. A population is considered a priority if it is critical for MPG or DPS viability.*
- *Actions that protect or enhance viability of multiple steelhead populations.*
- *Actions that support conservation of unique and rare functioning habitats, habitat diversity, life histories and genetic attributes.*
- *Actions that target the key limiting factors and that contribute the most to closing the gap between current status and desired future status of priority populations.*
- *Actions that provide critical information needed for assessing success and making adaptive management decisions.*

We consider the following types of actions to be high priority but less than highest:

- *Actions that enhance the habitat conditions and restore natural ecological processes of priority extant populations and their primary life history strategies throughout the entire life cycle.*
- *Actions that enhance the viability of priority extant populations.*
- *Actions that are required to protect and enhance habitats for populations that are not critical for MPG or ESU viability but must be maintained.*

Other things being equal, actions that demonstrate the following have enhanced priority:

- *Actions where opportunity for success is high (rather than those of limited feasibility).*
- *Actions that likely produce a large (rather than small) improvement in viability attributes.*
- *Actions that support restoration of normative ecological processes rather than short-term substitutions for normative processes.*
- *Actions that are complementary to other land management, water quality, environmental management and recreational objectives as specified in fish management, conservation, recovery or other plans developed with and supported by regional and subbasin stakeholders (rather than those that are isolated, stand-alone efforts).*
- *Actions that have regional and local support and generate increased participation.*
- *Actions that demonstrate cost effectiveness relative to alternative means of achieving the same objectives.*
- *Actions which have high degree of certainty in effectiveness and outcome.*

Source: Recovery Plan for Oregon's Middle Columbia Steelhead, Oregon Dept. of Fish and Wildlife, September 2007, p. 9-2

The Oregon Steelhead Recovery Plan also proposes the following measures to address hatchery related genetic and ecological effects on natural populations of Middle Columbia steelhead:

- Increase efforts to monitor incidence of hatchery fish on spawning grounds.
- Develop and implement plan for steelhead reintroduction into historical habitat when passage is restored.

- Eliminate the use of hatchery produced adults in the Umatilla River brood stock.
- Construct trapping facilities in the Deschutes River basin to remove stray hatchery fish.
- Use selective recreational fisheries to reduce the number of out-of-basin hatchery strays.

7.5.2 Washington Gorge Management Unit Plans

The Washington Gorge plans (White Salmon, Klickitat, and Rock Creek), identify recovery strategies in the same general order of importance as in the Oregon Steelhead Recovery Plan.

7.5.2.1 Klickitat Recovery Plan

The Klickitat plan's recovery strategy aims to remove threats to the long-term survival of the steelhead population and improve population biological characteristics so it will meet viability requirements and support DPS recovery. The primary focus of the strategy is to remove threats to the population posed by habitat degradation and hatchery practices by (1) improving and increasing habitat for steelhead production in the subbasin, and (2) minimizing impacts from hatchery releases on naturally produced steelhead in the Klickitat drainage, possibly by replacing the current releases of Skamania stock summer steelhead with fish produced from broodstock of naturally produced steelhead from the Klickitat River. The plan also recommends maintaining current low harvest rates to support efforts to improve steelhead viability.

The Klickitat recovery plan identifies strategies to address the ICTRT's findings that current data gaps and minimal data representative of a sufficient time series have resulted in uncertainty regarding the current status of the Klickitat population, and to improve potential adverse effects from current hatchery practices in the subbasin:

- Determine impact of hatchery steelhead releases on viability of Klickitat steelhead population.
- Minimize adverse impacts of hatchery releases on natural steelhead spawning population.
- Improve steelhead passage at Lyle Falls Fishway.
- Assess steelhead natural recolonization of upper Klickitat watershed and the potential use of artificial propagation to accelerate recolonization.
- Minimize adverse impacts of large-scale hatchery releases of *U.S. v. Oregon* production stocks (coho and fall Chinook) on Klickitat steelhead.
- Determine and minimize impacts of hatchery trout releases in the subbasin.

7.5.2.2 Rock Creek Recovery Plan

The Rock Creek plan's recovery strategy aims to remove threats to the long-term survival of the population and improve population biological characteristics so it will, first, meet requirements for a Maintained population and support DPS recovery and, eventually, achieve viability and meet broader population goals. The recovery strategy focuses on (1) gaining information needed to better assess population status and (2) removing key threats to population viability by improving freshwater habitat conditions.

7.5.2.3 White Salmon Recovery Plan

The White Salmon plan's recovery strategy contains two key parts: 1) a plan for reintroducing naturally produced steelhead into historical habitat after the removal of Condit Dam, and 2) improving and increasing freshwater habitat for steelhead production in the subbasin. The plan also recommends ensuring that harvest or hatchery actions do not impede efforts to improve steelhead viability. The reintroduction plan is being developed by the White Salmon Technical Working Group.

7.5.3 Yakima Steelhead Recovery Plan

Since the Yakima management unit encompasses all the populations of one MPG, the Yakima Steelhead Plan is structured to present a recovery strategy at the MPG-level. For this reason, the details of the Yakima recovery strategy are presented above in Section 7.2.3, Yakima River MPG.

7.5.4 Southeast Washington Plan

The SRSRB developed its recovery strategies by means of a set of "strategic guidelines" weighed against proposed actions. However, for habitat protection and restoration actions, "imminent threats" to fish life in areas containing ESA-listed populations will receive the highest priority. Examples of imminent threats include adult fish passage barriers such as culverts or dams, unscreened or poorly screened irrigation diversions, stream crossings (fords or low water crossings) that are located in spawning areas and are used during the incubation period, dewatered reaches that strand or kill fish and act as passage barriers, and point sources of toxic pollutants. Removing imminent threats will likely result in the greatest increase in fish survival over the shortest time.

The overall strategic guidelines are as follows:

1. Emphasis will be placed on projects with long persistence time ("life span") and benefits distributed over the widest possible range of environmental attributes.
2. Recovery/restoration actions must include immediate measures in addition to long-term actions. Many actions that address the root causes of habitat degradation require a long time to achieve their goals. An example would be planting trees in riparian zones to a) reduce instream temperatures, b) add large woody debris, and c) increase habitat complexity. Immediate actions which can "jump start" recovery can include such things as manual addition of large woody debris to stream channels, and creation of meanders in channelized streams.
3. The management strategy will involve "adaptive management"; that is, it will be a feedback system where changes in information or data detected through monitoring and evaluation will be used to adjust and modify plans and actions.
4. Identification of important areas and proposed actions is based substantially on information contained in the applicable subbasin plans.
5. Actions necessary to accomplish the recovery goals will be considered within the context of the four "Hs" (habitat, harvest, hatcheries, and hydroelectric).
6. Actions implemented within the region will be focused primarily on restoration and protection of habitat; actions pertinent to the other "Hs" will be addressed primarily

through other planning processes, but the SRSRB may provide recommendations to these processes.

7. The EDT analysis tool, in combination with other analyses, empirical data and professional opinion, will be used to identify and prioritize habitat actions.
8. The final set of proposed actions will be subject to economic, social, and cultural constraints identified by the recovery region.
9. Priority actions are those which the SRSRB hopes to accomplish over the 15-year planning period of this plan.

In general, the habitat strategy is based on protection of high quality or productive habitat and restoration, preferably passive restoration, to revitalize degraded habitat. Specific habitat strategies were prioritized in the following way: Habitat characteristics or factors, such as substrate embeddedness, pools, or temperature, were correlated with general categories of appropriate action, such as improving riparian areas, improving channel and floodplain, or improving water quantity. The categories of action, called "approaches," were assigned priority in terms of effectiveness, technical feasibility, and cost/benefit. Objectives for restoration and protection were defined specifically; for example, the restoration objective for water temperature is to achieve a stream condition where the water temperature does not rise above 72° F for more than four days per month. The habitat factors were then arranged in order of importance for each major spawning area, and specific actions, funding sources, and potential costs were listed.

7.6 Summary of DPS Recovery Strategy

The recovery strategy for the Middle Columbia steelhead DPS is made up of the following elements:

- Address the limiting factors for each major population group and population, following the recommendations in the 2006 listing decision, making use of the strategies and actions developed in the management unit plans, in concert with the strategies and actions provided in the NMFS 2008 FCRPS Biological Opinion, NMFS Estuary Module, Hatchery and Genetic Management Plans (HGMPs) and Artificial Production for Pacific Salmon (Appendix C of Supplemental Comprehensive Analysis, NMFS 2008), fishery management planning through U.S. v. Oregon for mainstem fisheries and Fisheries Management Evaluation Plans for tributary fisheries.

- Address and coordinate DPS-wide and basin-wide issues through the Middle Columbia Forum (a bi-state, tri-tribe group convened by NMFS to provide input on the development and implementation of the DPS recovery plan).

- Coordinate research, monitoring, and evaluation throughout the range of the DPS

- Conduct periodic comprehensive reviews of new information generated through the research, monitoring, and evaluation program. Adapt the strategies and actions as appropriate to achieve the recovery plan goals.

NMFS believes that if this strategy is implemented and the biological response is as expected, the Middle Columbia steelhead DPS is likely to achieve viable status within 25 to 50 years.

8. SITE-SPECIFIC MANAGEMENT ACTIONS AND COST ESTIMATES

It is important to consider the unique characteristics and challenges of estimating time and cost for salmon and steelhead recovery, given the complex relationship of these fish to the environment and to human activities on land. NMFS estimates that recovery of the Middle Columbia steelhead DPS, like recovery for most of the ESA-listed Pacific Northwest salmon and steelhead, could take 50 to 100 years, although the optimistic view is that it could be much sooner. The management unit plans (Appendices A through F) contain extensive lists of actions to recover the Middle Columbia steelhead DPS populations. These projects were developed using the most up-to-date assessment of Middle Columbia steelhead recovery needs. The management unit plans focus, for the most part, on actions within the next 5 to 15 years. There are many uncertainties involved in predicting the course of recovery and in estimating total costs. Such uncertainties include biological and ecosystem responses to recovery actions as well as long-term and future funding.

8.1 Site-Specific Management Actions

The proposed site-specific management actions at the population level are described in detail in Appendices A through F. It is possible that some of these actions will not be funded and that others will be proposed or added. It is important to note that the management unit plans are dynamic and subject to change through the adaptive management process. Implementation plans are often updated annually and generally cover a 3-to-10-year period. The reader is urged to refer to the management unit plans for up-to-date implementation schedules.

Proposed site-specific actions for the mainstem Columbia River and estuary are described in detail in the FCRPS Biological Opinion (NMFS 2008) and the Hydro Module (in preparation), the Estuary Module (NMFS 2007), and in *Artificial Propagation for Pacific Salmon*, Appendix C of the Supplemental Comprehensive Analysis of the FCRPS Biological Opinion (NMFS 2008).

8.2 Cost Estimates

Cost estimates for recovery projects were provided by the management unit entities where available information was sufficient to do so. In some cases this was done in coordination with a NMFS economist at the Northwest Fisheries Science Center in Seattle using a regional recovery cost database, together with input and review from regional experts and representatives from the Middle Columbia DPS Forum in 2007.

Cost estimates for proposed recovery projects were developed using the methods described in each management unit plan. No cost estimates are provided for (1) baseline actions (programs that are already in existence and would occur regardless of this recovery plan), which are listed as Not Applicable (N/A); or (2) actions that need costs to be developed, need unit costs, and/or need project scale estimates, which are listed as To Be Determined (TBD). Each management unit will work with regional experts to identify costs, scale, or unit costs for actions that require more information during the public comment period. Individual management unit costs will be updated with this new information for the final steelhead DPS recovery plan.

The total estimated cost of restoring habitat for the Middle Columbia steelhead DPS is approximately $235 million over the initial 5-year period, and approximately $970 million for all DPS-wide recovery actions for which sufficient information exists upon which to base an estimate (Table 8-1). This estimate includes expenditures by local, tribal, state, and Federal governments, private business, and individuals in implementing both capital projects and non-capital work. Administrative costs are embedded in the total management unit cost estimates in Table 8-1. Preliminary research, monitoring and evaluation costs have, in some cases, been estimated at the management unit level; however, these costs are not included at this time pending completion of research and monitoring plans and further development of each project.

Table 8-1 Summary of Cost Estimates for Habitat Projects for Middle Columbia Steelhead DPS

Recovery Plan	First 5 Years ($M)	Project/Program Total ($M)
Oregon	$ 103.5	$ 512.8
Yakima Steelhead[38]	$ 91.9	$ 269.3
SE Washington[39]	$ 25.5	$ 76.4
Klickitat[40],[41]	$ 12.9	$ 103.6
Rock Creek[42]	$ 1.0	$ 1.8
White Salmon Steelhead	N/A	$ 6.5
DPS Totals	**$ 234.8**	**$ 970.4**

The estimates in Table 8-1 do not include costs associated with baseline actions because these are actions categorized as part of ongoing, existing programs that will be carried out regardless of this recovery plan. Baseline actions do not represent new costs specific to steelhead recovery. The success of steelhead recovery is, however, dependent upon the continued support of ongoing baseline projects and programs.

There are several cautions that must be highlighted regarding these summary costs, because many of these estimates may be incomplete until actions are better defined. For example, the costs for potentially expensive projects such as land and water acquisition, water leasing, and

[38] The Yakima steelhead plan estimates costs for the first 6 years, and includes preliminary RME cost estimate of $300K/year. The 5-year estimate is extrapolated from the 6-year cost data .
[39] The SE Washington plan estimates annual steelhead implementation costs at about $5 million per year. The 5-year estimate is extrapolated by multiplying the annual amount by five.
[40] The Klickitat plan estimates costs for the first 10 years. Five-year estimate extrapolated by dividing the 10-year amount in half.
[41] The Klickitat plan uses a 50-year period to estimate its total project costs.
[42] The Rock Creek plan estimates cost for first 3 years and 10 years. The 5-year estimate is extrapolated from the 3-year value.

research and monitoring have not yet been estimated for many populations. For other projects, unit cost estimates or determination of project scale may also still need to be calculated. Therefore, Table 8-1 presents preliminary summary costs for recovery that will likely increase when unit cost estimates, scale of projects, and costs for actions are determined and as projects are better defined.

These cost estimates do not include expenses associated with implementing actions within the lower Columbia River, estuary, or Federal Columbia River Power System (FCRPS), first, because of the basin-wide scope and applicability of these actions to all 13 Columbia Basin salmonid species listed as threatened or endangered, and second, because they are considered "baseline actions" that are required through other processes such as section 7 consultations, FERC licensing agreements, and Habitat Conservation Plans, and these costs would occur regardless of the recovery plans. Cost estimates for estuary actions are included in a module that is incorporated into the Plan by reference, and is available on the NMFS Web site: www.nwr.noaa.gov/Salmon Recovery Planning/ESA Recovery Plans/Other Documents.cfm. The estuary recovery costs could be further refined following public comment on the module and on the ESA recovery plan for the three listed lower Columbia River ESUs and one listed lower Columbia River steelhead DPS in 2008 or early 2009. Costs for hatchery actions required through other processes such as consultations, permits, and 4(d) Rule implementation are not part of recovery costs reported here because the programs are already in existence or are undergoing required modifications, and the costs would occur regardless of the recovery plan. There are few estimated costs for recovery actions associated with harvest to report at this time. This is because no actions are currently proposed that go beyond those already being implemented through U.S. v. Oregon and other harvest management forums. In the event that additional harvest actions are implemented through these forums, those costs will be added during the implementation phase of this recovery plan. All cost estimates will be refined and updated over time.

Cost estimates from the draft cost chapters in the individual management plans were developed as consistently as possible, in that they all applied guidance provided by NMFS staff. However, the approaches vary to some degree given the local and independent nature of the planning groups. Costs developed in the management unit plans were estimated using several basic assumptions (i.e., neither baseline costs nor out-of-basin costs were included in the estimates) and used similar cost calculation methodologies. There are, however, differences in the timeframes for cost estimates, whether administrative costs were included or not, and whether research, monitoring and evaluation costs were calculated.

The proposed management unit plans' cost estimates will be refined based on public comment, and final cost estimates will be included in the final DPS recovery plan and management unit plans. The management unit draft cost estimates are summarized below.

8.2.1 Oregon Middle Columbia Steelhead Recovery Plan

Oregon's draft Middle Columbia Steelhead Recovery Plan presents extensive cost information for proposed recovery actions by strategies and populations in its Section 11 (Recovery Cost Summary Table) and two cost tables in Appendix I. Cost estimates for proposed recovery projects were developed using the unit cost method described in Section 11. Table I-1 (All

Actions by Population, Strategy and Category) in Appendix I summarizes estimated total costs that can currently be identified for recovery actions in each Oregon population and strategy. These do not include certain high cost actions such as land and water acquisition or water leases. ODFW will work with regional experts to identify costs, scale or unit costs for actions that need more information during the public comment period. The Oregon Steelhead Recovery Plan's Appendix I, Table I-1 will be updated with this new information for the final recovery plan. The total expected 5-year expenditures for all populations is $103,537,000. The overall total cost estimate for all proposed actions, where costs are available, for all populations is $512,843,328.

8.2.2 Yakima Steelhead Recovery Plan

The Yakima Steelhead Plan (Appendix D) identifies preliminary cost estimates for each action in accordance with NMFS' guidelines for developing cost estimates. The Plan categorizes each project's implementation as occurring over time spans of 0-3 years, 4-6 years, 6-10 years, or > 10 years. The estimate for projects expected to be completed within the first 6 years is approximately $110 million. The estimated total cost of recovery, for projects where sufficient information upon which to base an estimate exists, is approximately $211million.

8.2.3 Snake River Salmon Recovery Plan for Southeast Washington

The Southeast Washington Plan contains a 5-year implementation plan (2006-2011) that contains actions that can be carried out in the near future to reduce threats to listed fish. The plan's cost estimates are based on unit cost estimates for each type of project envisioned for seven major spawning areas (MSA) in which listed fish reside. Of these, four MSAs are home to Mid Columbia steelhead. For steelhead in these MSAs, the plan estimates implementation cost as approximately $5 million per year and approximately $76 million for total costs to recovery, exclusive of monitoring and evaluation.

8.2.4 Klickitat Recovery Plan

Costs for habitat recovery actions are estimated at approximately $26 million for years 1-10, approximately $104 million for years 11-50, and $130 million over a 50-year period. The funds to cover improvements at Lyle Falls and Castille Falls total $5.9 million (Klickitat Plan, Appendix B to this plan). Ongoing and expanded monitoring and evaluation activities are estimated to cost $907,783 in 2009 and increase to $1,474,843 in 2012 (Klickitat Plan, Appendix B to this plan).

8.2.5 Rock Creek Recovery Plan

The plan estimates funding needs for the first 3 years at approximately $600 thousand. Total costs for recovery, expected to occur over a 10-year period, are approximately $1.8 million. Other costs will be developed as actions are proposed and implemented.

8.2.6 White Salmon Steelhead Recovery Plan

The plan estimates costs for implementing the proposed habitat actions for the White Salmon drainage, based on the costs of specific reach actions identified in the plan. Habitat action costs for recovery over a ten-year time period are estimated to be $6.5 million ($2.17 million for years 1-3 and $4.33 million for years 4-10).

8.3 Time Estimate

NMFS estimates that recovery of the Middle Columbia steelhead DPS, like recovery for most of the ESA-listed Pacific Northwest salmon and steelhead, could take 50 to 100 years, although the optimistic view is that it could be much sooner. While the management unit plans contain extensive lists of actions to recover the Middle Columbia steelhead DPS populations, there are many uncertainties involved in predicting the course of recovery and in estimating total costs. Such uncertainties include biological and ecosystem responses to recovery actions as well as long-term and future funding. While continued programmatic actions in the management of habitat, hatcheries, hydro, and harvest will warrant additional expenditures beyond the first 10 years, NMFS believes it is impracticable to estimate all projected actions and costs over 50 to 100 years, given the large number of economic, biological, and social variables involved. NMFS believes it is appropriate to focus on the first 10 years of implementation, with the proviso that before the end of the first implementation period, specific actions and costs will be estimated for subsequent years, to achieve long-term goals and to proceed until a determination is made that listing is no longer necessary.

9. POTENTIAL EFFECTS OF PROPOSED RECOVERY ACTIONS

This chapter presents an analysis of the potential effects of proposed recovery actions on the abundance and productivity of Middle Columbia River steelhead. Estimated levels of effectiveness for the proposed actions are generated and used as inputs into quantitative models to project the potential impacts of those changes on populations. In most cases, results are expressed as changes in steelhead abundance and productivity compared to the "baseline" abundance and productivity that the ICTRT calculated for the period 1980-2001. These quantitative analyses provide an opportunity to evaluate the efficacy of proposed recovery strategies in light of current knowledge regarding population functioning, including relationships with habitat conditions. Equally important, the quantitative models used in the assessment provide a framework for productively targeting evaluation efforts as well as for revisiting key assumptions in the future as more information becomes available (e.g., from monitoring responses to initial implementation or from evaluation efforts targeting key uncertainties).

The analyses were performed sequentially, first by projecting effects for tributary habitat actions alone, then sequentially adding in hatchery, hydro, predation, estuary, and harvest actions. The results at each step provide a means for comparing estimated relative benefits of the proposed suites of actions, and, finally, the potential benefit of all the proposed actions to the Middle Columbia steelhead DPS. Last, these results are compared to the gaps identified by the ICTRT (see Chapter 5 of this Plan).

Two models were used: Ecosystem Diagnosis and Treatment (EDT) and the All-H-Analyzer (AHA). The EDT model has commonly been used in regional planning efforts across the DPS to evaluate potential responses to tributary habitat restoration efforts. The EDT model uses derived relationships between habitat characteristics and fish survival to calculate changes in survival, abundance, and productivity that could result from changes in the habitat. Use of the EDT model requires a set of inputs that describe current habitat conditions and the expected changes in habitat conditions that would result from a proposed action scenario. This model could be used, for example, to calculate the improvement that would be expected from a 10 percent drop in water temperature during the period of egg incubation in a certain tributary reach. The AHA model encompasses prospective relationships between all the "H" factors: habitat, hatcheries, hydro, and harvest. Thus, the results of the EDT model become one set of information fed into the AHA model to produce an estimate of the benefits of all the proposed actions.

For the Oregon populations, modifications were made to the EDT and AHA models to improve their application for this analysis. These modifications or refinements are described in Chapter 10 of the Oregon Steelhead Recovery Plan (Appendix A), as follows:

"EDT and AHA address different life stages in the life cycle and thus the different limiting factors that affect salmonid population performance (Figure 10-1). We incorporated several refinements to the modeling procedures for each platform as they are usually employed in the region to improve application for our objectives. For EDT, we formulated an auxiliary tool for defining action effectiveness to better ensure that we considered the distinct elements of effectiveness consistently between actions and subbasins, and we incorporated an implementation timeframe element. For AHA, we disaggregated the life cycle into more segments than used in

the standard AHA in order to completely incorporate the effects of habitat conditions in the juvenile life stages following emigration from the subbasin through the adult life stages, until return to the subbasin. We also formulated a module for AHA to provide an efficient way of processing the large number of action combinations—both in tributaries and the mainstem Columbia—of interest to this analysis. In addition, we modified the default settings in AHA for genetic fitness to produce results that appear to be more consistent with how the populations of interest are currently performing." (ODFW 2008)

The models indicate, based on the suites of proposed actions in all the sectors, that all Middle Columbia River steelhead populations for which there are adequate data are expected to achieve less than 5 percent risk for abundance/productivity if the most intensive (major) restoration scenarios are implemented and the projected habitat changes are realized. Under minimum restoration scenarios, three populations (Deschutes Westside, Satus, and Upper Yakima) may not achieve less than 5 percent risk for abundance/productivity. However, even under poor ocean conditions and minimum restoration actions, the abundance and productivity of these three populations are expected to increase considerably over the baseline.

The results of the modeling analyses of the restoration scenarios are summarized by population in Section 9.2, by MPG in Section 9.3 and for the DPS in Section 9.4. Section 9.1 describes technical aspects of the analytical method.

9.1 Integration Approach

The analysis of action effectiveness for all populations except Rock Creek was performed using two modeling platforms: Ecosystem Diagnosis and Treatment (EDT) and the All-H-Analyzer (AHA). Linking the two models provided a way of projecting benefits measured at the end of the life cycle for a wide range of actions, regardless of what life stage an action affects.

For the Oregon Middle Columbia steelhead populations and for a description of the modeling approach, this chapter relies substantially on the analysis performed by ODFW biologists and detailed in Section 10 of the Oregon Steelhead Recovery Plan (ODFW 2008). The Oregon analyses considered tributary habitat changes projected for reach specific action strategies. The Yakima and SE Washington area population level model assessments incorporated results from more generic EDT tributary habitat restoration scenario analyses.

Estimates of the relative changes in population abundance and productivity associated with potential changes in tributary habitat conditions for the Touchet and the four Yakima populations were compiled in the regional recovery plans. A set of estimates for the Klickitat population was provided by Yakama Nation Fisheries biologists. All of these estimates for Washington area steelhead populations were based on EDT model runs generated for previous planning exercises (e.g., NWPPC 2004 Subbasin Plans).

Benefits associated with proposed actions for the Rock Creek steelhead population were estimated with the simple, multiplicative approach used in NMFS' 2008 FCRPS Biological Opinion (Comprehensive Analysis of Federal Columbia River Power System and Mainstem Effects of Upper Snake and Other Tributary Actions [CA]) and the Supplemental CA [SCA]).

This approach estimated only density-independent survivals, unlike EDT and AHA, which modeled density dependent effects.

9.1.1 EDT Model

The EDT model was used to analyze the potential benefits of tributary habitat actions. In the Oregon Steelhead Recovery Plan, four scenarios were modeled for each Oregon Mid-C steelhead population, using EDT: (1) actions only in high priority areas at 25 years in the future; (2) actions only in high priority areas at 100 years in the future; (3) actions in all priority areas at 25 years in the future; and (4) actions in all priority areas at 100 years in the future. The expected change in habitat conditions assuming that the tributary protection and restoration actions are implemented following the general schedule described for each population was input into the EDT model for each scenario. The model results for a particular scenario represent the expected average performance of a population over a number of years given the specified habitat conditions. In addition, the Deschutes Westside population was modeled with and without passage at the Pelton-Round Butte Complex to estimate added benefits of passage and restoration of natural production in the blocked areas (see Oregon Steelhead Recovery Plan for more details).

Assessments of the potential response to tributary habitat changes resulting from implementation of the proposed actions for the Washington area populations were adapted from EDT analyses generated in developing the 2004/2005 NWPPC subbasin plans. Some modifications were made to reflect updates to the proposed tributary actions incorporated into the regional draft recovery plans. A single recovery action scenario was modeled for Washington populations, the model results represent the expected average performance of a population over a period of years given the projected changes in habitat conditions input into the EDT model corresponding to the proposed recovery strategy. For populations in Washington, no distinction was made between high priority actions and other actions; all actions were modeled, and future time horizons were only specified for the Walla Walla and Touchet populations (10-15 years future). Therefore, to complete the exercise for the Walla Walla population, which spawns in both states, the model combined Washington actions (10-15-year time horizon) with Oregon actions (all priority actions) using the 25-year time horizon.

Two different restoration scenarios were modeled for populations in the Yakima Basin. The first scenario, referred to as “minimum habitat restoration,” used an updated version of the reference conditions from the Yakima Subbasin Plan, as described in the Yakima Steelhead Recovery Plan. The second scenario, referred to as “major habitat restoration,” assumed that restoration actions will achieve about 50 percent of “properly functioning conditions” (a standardized set of criteria for watershed restoration [NMFS 1996]), across the basin. For both the Satus Creek and Toppenish River populations, the scenarios assumed that the basin consisted predominantly of anadromous life history types. For the Naches and Upper Yakima populations, the model was configured to partition habitat between resident and anadromous life history types and assume a steady-state abundance for resident fish. Performance of the Klickitat population was also modeled under two different restoration scenarios. One included restoring conditions in areas already used by steelhead (i.e., it did not include recolonization of areas upstream from Castile Falls); the other included recolonization of the upper watershed (upstream from Castile Falls) and restoration of habitat throughout the basin. Both restoration scenarios assumed that major limiting factors would be restored to 40 percent effectiveness.

For Oregon populations, the Oregon Steelhead Recovery Plan considered the influence of five factors for determining how effective an action may be in improving habitat conditions. The five factors were: (1) potential effectiveness – maximum effect of action type when fully implemented in targeted area; (2) intensity – scale of implementation within the targeted geographic area; (3) time lag – amount of potential effectiveness realized after 25 or 100 years; (4) schedule – delay in realizing potential effect due to implementation schedule; and (5) attribute – amount of reduced effectiveness associated with a specific attribute. The product of these scalars resulted in a "realized effectiveness" for each attribute (see Section 10.1.2 in the Oregon Steelhead Recovery Plan for more details).

9.1.2 AHA Model

The purpose of using the AHA model was to integrate the effects of various types of actions over the full life cycle of the fish. In the AHA model, the EDT analyses of tributary habitat actions were linked to prospective recovery actions involving hatchery fish and the mainstem Columbia River. This provided a way of projecting benefits measured at the end of the life cycle for a wide range of potential actions, regardless of what life stage an action affected. Section 10 in the Oregon Steelhead Recovery Plan describes in detail the AHA modeling approach.

For all populations except Rock Creek, AHA was used to model a set of scenarios representing baseline conditions (average conditions for migration years 1980-2001), current conditions (average conditions for migration years 2002-2006), and combinations of actions aimed at tributary habitat, mainstem Columbia River factors, and hatchery fish management. The model allowed the inclusion of potential effects of hatchery programs on the genetic fitness of the naturally produced populations. It also included several prospective actions to be implemented in the mainstem Columbia River, including: predator management – aimed at reducing predation rates caused by terns and northern pikeminnow; downstream juvenile passage improvements – measures to improve survival at each of the mainstem dams; Columbia estuary habitat improvements – measures to enhance habitat conditions within the Columbia estuary; and harvest – regulatory measures to reduce or hold harvest impacts in the mainstem Columbia River to current levels. The model incorporated survival improvement estimates for predation, hydrosystem, and estuary actions that were provided in the CA and SCA reports.

Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially. Using AHA, the effects of hatchery programs on genetic fitness of natural-origin fish were incorporated for each scenario. Actions intending to control the number of stray hatchery fish in subbasins were modeled as part of another set of scenarios. Finally, the effects of potential changes in marine survival were modeled. All of the scenarios were modeled using an average marine survival rate corresponding to the average during both the baseline and current periods. Then, two additional scenarios were modeled; one representing relatively good ocean conditions (125 percent of the average condition) and the other representing relatively poor ocean conditions (75 percent of the average condition).

The output from AHA was expressed as Beverton-Holt population parameters, which represent the expectations of change for each population's abundance and productivity as a result of all the proposed actions. This change can be thought of as a percent change (e.g., 25%) or a ratio (e.g.,

1.25). This needed to be "translated" into the same terms as the ICTRT's baseline abundance and productivity calculations for each population, which were derived empirically. Therefore, the ICTRT's baseline abundance and productivity values for each population were multiplied by the percent of change estimated by the AHA model. For example, if the AHA model indicated that abundance for a certain population will increase by 25 percent as a result of the proposed actions, then the ICTRT baseline abundance for that population was multiplied by 1.25 to get the projected estimate for abundance for that population under the recovery scenario. These calculations are described fully in Section 10.1 in the Oregon Steelhead Recovery Plan and shown in Figure 10-2 in the Oregon Steelhead Recovery Plan.

9.2 Effects of Recovery Actions

This section presents a summary of results of the benefits of proposed actions on Middle Columbia steelhead populations (see respective management unit recovery plans [Appendices A-F]for more detail). Changes in performance measures associated with each action scenario are presented for intrinsic productivity and spawner abundance. Except where noted otherwise, the results are comparable to population metrics for baseline performance, as derived empirically by the ICTRT, and to minimum productivity (at the threshold abundance level) and abundance viability thresholds at the 5 percent risk level in a 100-year time period. Performance measures are given for three periods: base period (1980-2001), base-current period (2002-2006), and the current-prospective period (2006-future). The latter varies depending on population. For those populations entirely within Oregon, the prospective period includes results at 25 and 100 years in the future. For Walla Walla and Touchet populations, results are projected ≤ 25 years in the future, while those in the Yakima and Klickitat have no defined future time horizon. A more detailed presentation of results for Oregon populations can be found in Sections 10.2 and 10.3 in the Oregon Steelhead Recovery Plan.

9.2.1 Eastern Cascades Slope Tributaries MPG

Deschutes River Westside Population
Abundance and productivity are projected to increase for all scenario combinations analyzed for Deschutes River Westside steelhead (Table 8.4; Oregon Steelhead Recovery Plan). The largest increases in population performance are associated with decreasing the number of stray hatchery fish and/or by providing passage at the Pelton-Round Butte Complex (including passage at Whychus Creek barriers). In the absence of the removal of strays or passage, benefits are much reduced. For those scenario combinations lacking removal of strays and passage, beneficial effects of tributary actions are greatest. However, predicted increases in abundance and productivity associated with habitat actions are less than 20 percent and between 35-55 percent, respectively.

Table 9-1 shows estimated abundance and productivity for the Deschutes River Westside population associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with and without passage at Pelton-Round Butte Dam Complex and with and without action to reduce the number of hatchery strays by 95 percent of those expected to enter the relevant area for the scenario. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25 percent represents performance of combined actions under relatively poor and good ocean

conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. Data are from Table 10-39 in the Oregon Steelhead Recovery Plan.

Table 9-1. Estimated productivity and abundance of Deschutes River Westside steelhead with proposed actions

Performance period	Scenario combination	Performance metric					
		Productivity			Abundance		
		No passage and no stray action	No passage with stray action	Passage with stray action	No passage and no stray action	No passage with stray action	Passage with stray action
Base		1.05			456		
Base-Current		1.17	1.84		514	557	
Current-Prospective (25 yrs future)	Habitat	1.59	2.44	2.39	578	610	880
	Hydro	1.67	2.57	2.52	610	641	925
	Predation	1.74	2.68	2.63	638	669	966
	Estuary	1.84	2.84	2.78	675	707	1,020
	Harvest	1.84	2.84	2.78	675	707	1,020
	Ocean ±25%	1.38-2.29	2.13-3.55	2.08-3.47	497-844	530-875	763-1,263
Current-Prospective (100 yrs future)	Habitat	1.82	2.78	2.74	630	660	931
	Hydro	1.92	2.92	2.88	665	694	978
	Predation	2.00	3.05	3.01	696	725	1,020
	Estuary	2.11	3.23	3.18	738	767	1,077
	Harvest	2.11	3.23	3.18	738	767	1,077
	Ocean ±25%	1.59-2.64	2.42-4.03	2.39-3.98	542-927	571-955	810-1,329

Deschutes River Eastside Population

Abundance and productivity are projected to increase markedly for all scenario combinations analyzed for Deschutes River Eastside steelhead (Table 9.5; Oregon Steelhead Recovery Plan). The largest contribution to performance improvements results from tributary habitat actions, with the greatest benefits accruing for the 100-year scenario. It is predicted that between 50-70 percent of historic habitat potential for abundance will be achieved. The amount of habitat potential reflected in productivity, however, is somewhat less, being between 25-45 percent of potential. This means that the habitat actions will have a greater effect on habitat quantity than on habitat

quality. Substantial benefits to both productivity and abundance are also expected to occur as a result of reducing the number of stray hatchery fish spawning with naturally produced fish.

Table 9-2 shows estimated population performance (productivity and abundance) of Deschutes River Eastside steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with and without action to reduce the number of hatchery strays by 95 percent of those expected to enter the relevant areas for the scenario. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25 percent represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. Data are from Table 10-38 in the Oregon Steelhead Recovery Plan.

Table 9-2. Estimated productivity and abundance of Deschutes River Eastside steelhead with proposed actions

Performance period	Scenario combination	Performance metric			
		Productivity		Abundance	
		No stray action	With stray action	No stray action	With stray action
Base		1.89		1,599	
Base-Current		2.10	3.71	2,340	4,634
Current-Prospective (25 yrs future)	Habitat	4.26	6.80	6,973	8,323
	Hydro	4.47	7.15	7,471	8,818
	Predation	4.67	7.47	7,921	9,265
	Estuary	4.93	7.89	8,520	9,859
	Harvest	4.93	7.89	8,520	9,859
	Ocean ±25%	3.71-6.13	5.91-9.88	5,679-11,199	7,039-12,519
Current-Prospective (100 yrs future)	Habitat	5.97	9.20	8,643	9,619
	Hydro	6.26	9.67	9,174	10,151
	Predation	6.53	10.10	9,656	10,632
	Estuary	6.89	10.68	10,295	11,272
	Harvest	6.89	10.68	10,295	11,272
	Ocean ±25%	5.22-8.54	8.00-13.35	7,265-13,167	8,239-14,140

Klickitat River Population

Abundance and productivity are projected to increase for all scenario combinations analyzed for Klickitat River steelhead (Table 9-6; note that performance values in the table are direct output from EDT/AHA and have not been converted into ICTRT-equivalent performance values). The

largest contribution to performance improvements results from the combination of tributary habitat actions throughout the basin and recolonization of the upper watershed (recolonization of the upper watershed is possible because of passage improvements at Castile Falls). In contrast, relatively small increases are attributable to mainstem actions.

Table 9-3 shows estimated population performance (productivity and abundance) of Klickitat River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly from EDT/AHA and were not converted to ICTRT-equivalent performance values (the ICTRT was unable to empirically estimate baseline performance measures for this population because of a lack of data). Results are shown with and without recolonization of the upper watershed. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario.

Table 9-3. Estimated productivity and abundance of Klickitat River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric			
		Productivity		Abundance	
		Actions without recolonization of upper watershed	Actions with recolonization of upper watershed	Actions without recolonization of upper watershed	Actions with recolonization of upper watershed
Base		1.77		939	
Base-Current		1.92	1.92	1,118	1,118
Current-Prospective	Habitat	2.12	2.38	1,319	2,320
	Hydro	2.24	2.50	1,468	2,572
	Predation	2.29	2.56	1,538	2,692
	Estuary	2.36	2.62	1,630	2,850
	Harvest	2.36	2.62	1,630	2,850
	Ocean ±25%	2.01-2.64	2.27-2.90	1,181-2,026	2,088-3,539

Fifteenmile Creek Population

Abundance and productivity are projected to increase markedly for all scenario combinations analyzed for Fifteenmile Creek steelhead (Table 9.7; Oregon Steelhead Recovery Plan). The largest contribution to performance improvements results from tributary habitat actions. It is predicted that between 50-70% of historic habitat potential for both productivity and abundance will be achieved. In contrast, relatively small increases are attributable to mainstem actions.

Table 9-4 shows estimated population performance (productivity and abundance) of Fifteenmile Creek steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. Data are from Table 10-37 in the Oregon Steelhead Recovery Plan.

Table 9-4. Estimated productivity and abundance of Fifteenmile Creek steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric	
		Productivity	Abundance
Base		1.82	703
Base-Current		1.96	764
Current-Prospective (25 yrs future)	Habitat	3.02	1,342
	Hydro	3.02	1,345
	Predation	3.16	1,410
	Estuary	3.34	1,496
	Harvest	3.34	1,496
	Ocean ±25%	2.50-4.17	1,095-1,898
Current-Prospective (100 yrs future)	Habitat	3.79	1,502
	Hydro	3.80	1,506
	Predation	3.96	1,577
	Estuary	4.19	1,672
	Harvest	4.19	1,672
	Ocean ±25%	3.14-5.24	1,230-2,114

Rock Creek Population

Because no ETD/AHA modeling was conducted for Rock Creek steelhead, potential benefits in productivity were estimated with the multiplicative approach used in the FCRPS BiOp (CA and SCA reports). This approach did not estimate productivity or abundance values. Rather, it estimated changes in productivity associated with actions within each sector (habitat, hatchery, hydrosystem, predation, estuary, and harvest). Values for habitat should be considered a minimum estimate, given that the FCRPS BiOp assumed no habitat restoration actions in the subbasin.

Based on the survival changes presented in the FCRPS BiOp for each sector, Rock Creek steelhead productivity was projected to increase about 13% during the base-current period (Table

9-8). For the current-prospective period, productivity is projected to increase about 21%. Most of this increase is associated with actions in the hydrosystem and estuary.

Table 9-5 shows estimated proportional changes in average base-period productivity of Rock Creek steelhead expected from completed actions and current human activities that are likely to continue in the future (base-current) and proposed future tributary and out-of-subbasin actions (current-prospective). Estimates greater than 1.00 result in higher survival (e.g., 1.134 indicates a 13.4% increase in survival, compared to the base period average); 1.00 indicates no change; and estimates less than 1.00 result in lower survival (e.g., 0.997 indicates a 0.3% reduction in survival, compared to the base period average. Because no EDT/AHA modeling was completed for Rock Creek steelhead, estimated changes in productivity are from the FCRPS BiOp (SCA and CA reports).

Table 9-5. Estimated proportional changes in average base-period productivity of Rock Creek steelhead

Performance period	Scenario combination*	Change in Productivity
Base-Current	Habitat	1.000
	Hydro	1.090
	Predation	0.997
	Estuary	1.003
	Harvest	1.040
	Hatchery	1.000
	Total	1.134
Current-Prospective	Habitat	1.000
	Hydro	1.100
	Predation	1.044
	Estuary	1.057
	Harvest	1.000
	Hatchery	1.000
	Total	1.214

Tributary habitat estimates are from CA Chapter 10, Table 10-9; hydro estimates are from SCA Hydro Modeling Appendix B; predation estimates are from CA Appendix F, Attachment F-1 (for pikeminnow predation), CA Appendix F, Attachment F-2, Table 4, based on the "Prospective 2 S/Current 2 S" approach (for bird predation), and SCA Marine Mammal Appendix (for marine mammal predation); and estuary estimates are from CA Appendix D, Attachment D-1, Table 6. The analyses assumed no survival changes associated with harvest or hatchery programs. Total survival improvement multipliers are the product of the survival improvement multipliers in each previous row.

9.2.2 John Day River MPG

Lower John Day River Population

Abundance and productivity are projected to increase markedly for all scenario combinations analyzed for Lower John Day River steelhead (Table 9.9; Oregon Steelhead Recovery Plan). The largest contribution to performance improvements results from tributary habitat actions, with

greatest benefits accruing for the 100-year scenario. It is predicted that habitat actions can achieve about 31-40% of historic habitat potential for both productivity and abundance. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-6 shows estimated population performance (productivity and abundance) of Lower John Day River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. Data are from Table 10-40 in the Oregon Steelhead Recovery Plan.

Table 9-6. Estimated productivity and abundance of Lower John Day River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric	
		Productivity	Abundance
Base		2.99	1,800
Base-Current		3.44	2,423
Current-Prospective (25 yrs future)	Habitat	4.99	5,751
	Hydro	5.43	6,537
	Predation	5.65	6,918
	Estuary	5.94	7,427
	Harvest	5.94	7,427
	Ocean ±25%	4.61-7.33	5,047-9,722
Current-Prospective (100 yrs future)	Habitat	7.31	8,627
	Hydro	7.94	9,628
	Predation	8.25	10,112
	Estuary	8.67	10,758
	Harvest	8.67	10,758
	Ocean ±25%	6.77-10.66	7,728-13,667

North Fork John Day River Population

Abundance and productivity are projected to increase markedly for all scenario combinations analyzed for North Fork John Day River steelhead (Table 9.10; Oregon Steelhead Recovery Plan). The largest contribution to performance improvements results from tributary habitat actions, with greatest benefits accruing for the 100-year scenario. It is predicted that habitat actions can achieve about 45-55% of historic habitat potential for both productivity and

abundance. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-7 shows estimated population performance (productivity and abundance) of North Fork John Day River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. Data are from Table 10-41 in the Oregon Steelhead Recovery Plan.

Table 9-7. Estimated population performance (productivity and abundance) of North Fork John Day River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric	
		Productivity	Abundance
Base		2.41	1,740
Base-Current		2.77	2,101
Current-Prospective (25 yrs future)	Habitat	3.44	2,762
	Hydro	3.77	3,090
	Predation	3.94	3,248
	Estuary	4.16	3,458
	Harvest	4.16	3,458
	Ocean ±25%	3.14-5.18	2,465-4,404
Current-Prospective (100 yrs future)	Habitat	4.03	3,209
	Hydro	4.42	3,572
	Predation	4.61	3,747
	Estuary	4.87	3,980
	Harvest	4.87	3,980
	Ocean ±25%	3.69-6.06	2,880-5,028

Middle Fork John Day River Population

Abundance and productivity are projected to increase markedly for all scenario combinations analyzed for Middle Fork John Day River steelhead (Table 9.11; Oregon Steelhead Recovery Plan). The largest contribution to performance improvements results from tributary habitat actions, with greatest benefits accruing for the 100-year scenario. It is predicted that habitat actions can achieve about 40-55% of historic habitat potential for both productivity and

abundance. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-8 shows estimated population performance (productivity and abundance) of Middle Fork John Day River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. Data are from Table 10-42 in the Oregon Steelhead Recovery Plan.

Table 9-8. Estimated population performance (productivity and abundance) of Middle Fork John Day River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric	
		Productivity	Abundance
Base		2.45	756
Base-Current		2.82	921
Current-Prospective (25 yrs future)	Habitat	4.24	1,385
	Hydro	4.64	1,545
	Predation	4.84	1,622
	Estuary	5.11	1,724
	Harvest	5.11	1,724
	Ocean ±25%	3.88-6.35	1,240-2,186
Current-Prospective (100 yrs future)	Habitat	5.46	1,694
	Hydro	5.97	1,878
	Predation	6.23	1,966
	Estuary	6.57	2,084
	Harvest	6.57	2,084
	Ocean ±25%	5.00-8.15	1,528-2,616

South Fork John Day River Population

Abundance and productivity are projected to increase markedly for all scenario combinations analyzed for South Fork John Day River steelhead (Table 9.12; Oregon Steelhead Recovery Plan). The largest contribution to performance improvements results from tributary habitat actions, with greatest benefits accruing for the 100-year scenario. It is predicted that habitat actions can achieve about 40-55% of historic habitat potential for both productivity and abundance. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-9 shows estimated population performance (productivity and abundance) of South Fork John Day River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. Data are from Table 10-43 in the Oregon Steelhead Recovery Plan.

Table 9-9. Estimated population performance (productivity and abundance) of South Fork John Day River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric	
		Productivity	Abundance
Base		2.06	259
Base-Current		2.37	315
Current-Prospective (25 yrs future)	Habitat	3.03	414
	Hydro	3.32	464
	Predation	3.46	488
	Estuary	3.66	520
	Harvest	3.66	520
	Ocean ±25%	2.76-4.55	369-665
Current-Prospective (100 yrs future)	Habitat	3.72	491
	Hydro	4.07	546
	Predation	4.25	573
	Estuary	4.48	609
	Harvest	4.48	609
	Ocean ±25%	3.40-5.57	440-769

Upper John Day River Population

Abundance and productivity are projected to increase markedly for all scenario combinations analyzed for Upper John Day River steelhead (Table 9.13; Oregon Steelhead Recovery Plan). The largest contribution to performance improvements results from tributary habitat actions, with greatest benefits accruing for the 100-year scenario. It is predicted that habitat actions can achieve about 35-55% of historic habitat potential for both productivity and abundance. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-10 shows estimated population performance (productivity and abundance) of Upper John Day River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. Data are from Table 10-44 in the Oregon Steelhead Recovery Plan.

Table 9-10. Estimated population performance (productivity and abundance) of Upper John Day River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric	
		Productivity	Abundance
Base		2.14	524
Base-Current		2.46	650
Current-Prospective (25 yrs future)	Habitat	4.14	1,262
	Hydro	4.52	1,409
	Predation	4.71	1,480
	Estuary	4.97	1,575
	Harvest	4.97	1,575
	Ocean ±25%	3.79-6.16	1,129-2,004
Current-Prospective (100 yrs future)	Habitat	5.35	1,566
	Hydro	5.85	1,738
	Predation	6.09	1,821
	Estuary	6.42	1,931
	Harvest	6.42	1,931
	Ocean ±25%	4.91-7.95	1,411-2,431

9.2.3 Umatilla/Walla Walla MPG

Umatilla River Population

Abundance and productivity are projected to increase markedly for all scenario combinations analyzed for Umatilla River steelhead (Table 9.14; Oregon Steelhead Recovery Plan). The largest contribution to performance improvements results from tributary habitat actions, with greatest benefits accruing for the 100-year scenario. It is predicted that habitat actions can achieve about 45-70% of historic habitat potential for both productivity and abundance. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-11 shows estimated population performance (productivity and abundance) of Umatilla River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. Data are from Table 10-45 in the Oregon Steelhead Recovery Plan.

Table 9-11 Estimated population performance (productivity and abundance) of Umatilla River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric	
		Productivity	Abundance
Base		1.50	1,472
Base-Current		1.73	1,820
Current-Prospective (25 yrs future)	Habitat	3.18	3,685
	Hydro	3.50	4,092
	Predation	3.65	4,287
	Estuary	3.86	4,545
	Harvest	3.86	4,545
	Ocean ±25%	2.90-4.82	3,313-5,693
Current-Prospective (100 yrs future)	Habitat	4.03	4,355
	Hydro	4.42	4,808
	Predation	4.62	5,026
	Estuary	4.88	5,314
	Harvest	4.88	5,314
	Ocean ±25%	3.67-6.09	3,940-6,592

Walla Walla River Population

Abundance and productivity are projected to increase markedly for all scenario combinations analyzed for Walla Walla River steelhead (Table 9-12a and 9-12b). The largest contribution to performance improvements results from tributary habitat actions. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-12a shows estimated population performance (productivity and abundance) of Walla Walla River steelhead associated with combinations of all priority tributary and out-of-subbasin actions, including combined benefits of actions proposed in the Oregon portion of the Walla Walla basin with those proposed in the Washington portion of the basin. Population performance

measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario.

Table 9-12a. Estimated productivity and abundance of Walla Walla River steelhead associated with combinations of all priority tributary and out-of-subbasin actions, including both Oregon and Washington.

Performance period	Scenario combination	Performance metric	
		Productivity	Abundance
Base		1.34	650
Base-Current		1.60	864
Current-Prospective (25 yrs future)	Habitat	2.78	2,214
	Hydro	3.12	2,515
	Predation	3.25	2,634
	Estuary	3.44	2,790
	Harvest	3.44	2,790
	Ocean ±25%	2.58-4.30	2,033-3,465

Table 9-12b. Estimated population performance (productivity and abundance) of Walla Walla River steelhead associated with combinations of all priority tributary actions only within the Oregon portion of the Walla Walla basin and out-of-subbasin actions (this analysis does not include habitat actions proposed within the Washington portion of the Walla Walla basin). Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario. Data are from Table 10-46 in the Oregon Steelhead Recovery Plan.

Table 9-12b. Estimated productivity and abundance of Walla Walla River steelhead associated with combinations of all priority tributary actions within Oregon and out-of-subbasin actions (but not with actions in Washington).

Performance period	Scenario combination	Performance metric	
		Productivity	Abundance
Base		1.34	650
Base-Current		1.60	864
Current-Prospective (25 yrs future)	Habitat	2.51	1,576
	Hydro	2.81	1,779
	Predation	2.94	1,859
	Estuary	3.11	1,961
	Harvest	3.11	1,961
	Ocean ±25%	2.33-3.88	1,451-2,393
Current-Prospective (100 yrs future)	Habitat	2.76	1,730
	Hydro	3.09	1,944
	Predation	3.23	2,027
	Estuary	3.41	2,136
	Harvest	3.41	2,136
	Ocean ±25%	2.56-4.27	1,599-2,590

Touchet River Population

Because of a lack of empirical data for the Touchet River steelhead population, base productivity was estimated as the median of the empirical series of estimates for the Walla Walla and Umatilla populations. This resulted in an estimated productivity of 1.42 for the Touchet population. It is important to note that this value is only a surrogate and will be replaced with an empirically derived estimate after there is a data series of sufficient length.

Abundance and productivity are projected to increase for Touchet River steelhead (Table 9-13). A relatively large contribution to performance improvements should result from tributary habitat actions. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-13 shows estimated population performance (productivity and abundance) of Touchet River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Base productivity was estimated as the median of the empirical series of productivity from the Walla Walla and Umatilla populations. All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario.

Table 9-13. Estimated productivity and abundance of Touchet River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric	
		Productivity	Abundance
Base		1.42	310
Base-Current		1.69	387
Current-Prospective (10-15 yrs future)	Habitat	2.97	914
	Hydro	3.33	1,032
	Predation	3.48	1,078
	Estuary	3.67	1,139
	Harvest	3.67	1,139
	Ocean ±25%	2.57-4.59	609-1,402

9.2.4 Yakima MPG

Satus Creek Population (tributary only)
Abundance and productivity are projected to increase for all scenario combinations analyzed for Satus Creek steelhead (Table 9-14). The largest contribution to performance improvements results from tributary habitat actions, with greatest benefits accruing for the major habitat restoration scenario, which assumes that restoration actions will achieve about 50% of Properly Functioning Conditions across the watershed. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-14 shows estimated population performance (productivity and abundance) of Satus Creek steelhead (tributary only) associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with minimum habitat restoration actions (using reference conditions described in the Yakima Steelhead Recovery Plan) and major habitat restoration actions (restoring 50% of Properly Functioning Conditions across the subbasin). All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario.

Table 9-14. Estimated productivity and abundance of Satus Creek steelhead (tributary only) associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric			
		Productivity		Abundance	
		Minimum habitat restoration	Major habitat restoration	Minimum habitat restoration	Major habitat restoration
Base		1.73	1.73	379	379
Base-Current		2.06	2.06	487	487
Current-Prospective	Habitat	2.29	5.14	540	1,474
	Hydro	2.52	5.63	607	1,624
	Predation	2.63	5.87	639	1,696
	Estuary	2.78	6.19	682	1,793
	Harvest	2.78	6.19	682	1,793
	Ocean ±25%	2.09-3.46	4.70-7.70	478-870	1,338-2,225

Toppenish River Population

Abundance and productivity are projected to increase for all scenario combinations analyzed for Toppenish River steelhead (Table 9-15). The largest contribution to performance improvements results from tributary habitat actions, with greatest benefits accruing for the major habitat restoration scenario, which assumes that restoration actions will achieve about 50% of Properly Functioning Conditions across the watershed. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-15 shows estimated population performance (productivity and abundance) of Toppenish River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with minimum habitat restoration actions (using reference conditions described in the Yakima Steelhead Recovery Plan) and major habitat restoration actions (restoring 50% of Properly Functioning Conditions across the subbasin). All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario.

Table 9-15. Estimated population performance (productivity and abundance) of Toppenish River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric			
		Productivity		Abundance	
		Minimum habitat restoration	Major habitat restoration	Minimum habitat restoration	Major habitat restoration
Base		1.60	1.60	322	322
Base-Current		2.05	2.05	462	462
Current-Prospective	Habitat	2.32	4.78	564	1,597
	Hydro	2.55	5.23	635	1,760
	Predation	2.66	5.45	670	1,839
	Estuary	2.81	5.75	715	1,944
	Harvest	2.81	5.75	715	1,944
	Ocean ±25%	2.12-3.51	4.37-7.16	499-918	1,448-2,413

Naches River Population

Abundance and productivity are projected to increase for all scenario combinations analyzed for Naches River steelhead (Table 9-16). The largest contribution to performance improvements results from tributary habitat actions, with greatest benefits accruing for the major habitat restoration scenario, which assumes that restoration actions will achieve about 50% of Properly Functioning Conditions across the watershed. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-16 shows estimated population performance (productivity and abundance) of Naches River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with minimum habitat restoration actions (using reference conditions described in the Yakima Steelhead Recovery Plan) and major habitat restoration actions (restoring 50% of Properly Functioning Conditions across the subbasin). All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario.

Table 9-16. Estimated productivity and abundance of Naches River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric			
		Productivity		Abundance	
		Minimum habitat restoration	Major habitat restoration	Minimum habitat restoration	Major habitat restoration
Base		1.12	1.12	472	472
Base-Current		1.34	1.34	971	971
Current-Prospective	Habitat	1.63	3.20	1,575	5,427
	Hydro	1.76	3.43	1,860	5,997
	Predation	1.83	3.55	2,002	6,273
	Estuary	1.92	3.71	2,192	6,644
	Harvest	1.92	3.71	2,192	6,644
	Ocean ±25%	1.53-2.36	3.06-4.51	1,347-3,054	4,989-8,320

Upper Yakima River Population

Abundance and productivity are projected to increase for all scenario combinations analyzed for Upper Yakima River steelhead (Table 9-17). The largest contribution to performance improvements results from tributary habitat actions, with greatest benefits accruing for the major habitat restoration scenario, which assumes that restoration actions will achieve about 50% of Properly Functioning Conditions across the watershed. Benefits associated with mainstem actions are cumulative with the sequential addition of actions.

Table 9-17 shows estimated population performance (productivity and abundance) of Upper Yakima River steelhead associated with combinations of all priority tributary and out-of-subbasin actions. Population performance measures are directly comparable to those derived empirically for baseline conditions by the ICTRT. Results are shown with minimum habitat restoration actions (using reference conditions described in the Yakima Steelhead Recovery Plan) and major habitat restoration actions (restoring 50% of Properly Functioning Conditions across the subbasin). All scenario combinations include average ocean conditions (average during baseline and current conditions); ocean ±25% represents performance of combined actions under relatively poor and good ocean conditions. Scenarios were run in a stepwise fashion, starting with baseline, then current conditions, and then adding in actions sequentially, each being added to the previous scenario.

Table 9-17. Estimated productivity and abundance of Upper Yakima River steelhead associated with combinations of all priority tributary and out-of-subbasin actions.

Performance period	Scenario combination	Performance metric			
		Productivity		Abundance	
		Minimum habitat restoration	Major habitat restoration	Minimum habitat restoration	Major habitat restoration
Base		1.09	1.09	85	85
Base-Current		1.30	1.30	363	363
Current-Prospective	Habitat	1.46	2.58	923	3,809
	Hydro	1.50	2.62	1,041	4,089
	Predation	1.56	2.72	1,179	4,337
	Estuary	1.64	2.86	1,367	4,672
	Harvest	1.64	2.86	1,367	4,672
	Ocean ±25%	1.32-2.03	2.35-3.53	622-2,259	3,296-6,187

9.3 Aggregate Analysis

This section describes the integration of total "base-to-current" and total "current-to-future" productivity and abundance improvements expected from recovery actions. For simplicity, improvements are based on the benefits of all priority actions projected at ≤ 25 years into the future. In addition, unless noted otherwise, benefits described in this section are based on the least intensive restoration scenarios (e.g., scenarios without passage, without stray actions, etc.). "Overall" abundance/productivity benefits are then compared to the 5% risk curves (in a 100-year time period). Information on expected changes to spatial structure and diversity are not currently available.

9.3.1 Eastern Cascades MPG

Productivity. The combined effects of current and future recovery actions should result in productivity increases of at least 14 to 224%, compared to the "base" condition for Eastern Cascades populations (Table 9-18). Productivity for the Deschutes Eastside population is expected to increase the most (base to future = 96-224%). These percentages do not account for possible increases in productivity that could be gained by reducing the number of stray hatchery fish spawning with naturally produced fish. Productivity for the Deschutes Westside population, which has the largest survival gap in this MPG, is expected to increase 31-118% (base-future). These percentages do not include actions for passage (at the Pelton-Round Butte Complex and Whychus Creek) or decreasing the numbers of stray hatchery fish spawning in the population. Including these actions, productivity could be expected to increase 98-230%. Productivities in the other populations are expected to increase 14-129%.

Abundance. The combined effects of current and future recovery actions should result in abundance increases of at least 9 to 600%, compared to the "base" condition for Eastern Cascades populations (Table 9-19). Abundance for the Deschutes Eastside population should increase the most (base to future = 255-600%). Abundance in the Deschutes Westside population, which has the largest survival gap in this MPG, should increase 9-85%. Including passage and stray actions, the abundance of this population may increase 67-177%. The other populations in the MPG are expected to increase 26-170% in abundance.

Abundance/Productivity Risk. Only the Deschutes Westside population has an estimated survival gap (78% increase in survival needed to achieve 5% risk in a 100-year time period under base hydrosystem and recent ocean conditions). Gaps could not be estimated for the Klickitat or Rock Creek populations because of a lack of information. The other two populations (Deschutes Eastside and Fifteen Mile) had no survival gaps and the projected abundance/productivity estimates for these populations fell above the 5% risk curves (i.e., risk in a 100-year period was ≤ 5%) (Figure 9-1). The proposed actions for the Deschutes Westside population should result in ≤ 5% risk (in a 100-year time period) for abundance/productivity if actions intended to decrease the number of stray hatchery fish are implemented and passage is provided at the Pelton-Round Butte Complex. In the absence of stray actions and passage at Pelton-Round Butte, the projected benefit in abundance/productivity may not achieve ≤ 5% risk (Figure 9-1, bottom graph).

9.3.2 John Day River MPG

Productivity. The combined effects of current and future recovery actions should result in productivity increases of at least 30 to 188%, compared to the "base" condition for John Day populations (Table 9-18). Productivity is expected to increase the most for the Upper Mainstem population (base to future = 77-188%). For the South Fork population, which has the largest survival gap in this MPG, productivity is projected to increase 34-121% (base-future). For the Lower Mainstem and Middle Fork populations, which also have survival gaps, productivity is projected to increase 54-145% and 58-159%, respectively. Productivity for the North Fork population, which has no survival gap, is expected to increase 30-115% (base-future).

Abundance. The combined effects of current and future recovery actions should result in abundance increases of at least 42 to 440%, compared to the "base" condition for John Day populations (Table 9-19). Abundance is expected to increase the most for the Lower Mainstem population (base to future = 180-440%). For the South Fork population, which has the largest survival gap in this MPG, abundance is projected to increase 43-157% (base-future). For the Middle Fork population, which has a survival gap, abundance is projected to increase 64-189%. Abundance for the North Fork and Upper Mainstem populations is expected to increase 42-153% and 116-282%, respectively.

Abundance/Productivity Risk. The North Fork John Day population is the only population within the John Day MPG that is presently considered viable (at ≤ 5% risk in a 100-year period). The other populations within the MPG have survival gaps (Table 9-3). The proposed actions for all populations within this DPS should result in ≤ 5% risk (in a 100-year time period) for abundance/productivity (Figure 9-2).

9.3.3 Umatilla/Walla Walla MPG

Productivity. The combined effects of current and future recovery actions should result in productivity increases of at least 93 to 221%, compared to the "base" condition for the Umatilla and Walla Walla populations (Table 9-18). Productivity for the Walla Walla population, which has the largest survival gap in this MPG, is projected to increase 93-221% (base-future). For the Umatilla population, which has a survival gap, productivity is also expected to increase 93-221%. For the Touchet River, base productivity was estimated as the median of the empirical series of estimates for the Walla Walls and Umatilla populations. This is a surrogate value and will be replaced with an empirically derived estimate after there is a data series of sufficient length. Based on this interim value, productivity is expected to increase 52-172% (base-future).

Abundance. The combined effects of current and future recovery actions should result in abundance increases of at least 125 to 433%, compared to the "base" condition for Umatilla and Walla Walla populations (Table 9-19). Abundance for the Walla Walla population, which has the largest survival gap in this MPG, is projected to increase 213-433% (base-future). For the Umatilla population, which has a survival gap, abundance is also expected to increase 125-287%. Abundance for the Touchet population is expected to increase 57-262%.

Abundance/Productivity Risk. Of the three populations within the Umatilla/Walla Walla DPS, there are estimated survival gaps for the Umatilla and Walla Walla populations (Table 5-1). A gap for the Touchet population could not be estimated because of a lack of information. The proposed restoration actions for the Umatilla and Walla Walla populations should result in ≤ 5% risk (in a 100-year time period) for abundance/productivity (Figure 9-3). Assuming a base productivity of 1.42 for the Touchet population (this is the median of the Walla Walla and Umatilla populations) and a projected productivity and abundance of 3.67 and 1,139, respectively, the proposed restoration actions for the Touchet population should result in ≤ 5% risk.

9.3.4 Yakima MPG

Productivity. The combined effects of current and future recovery actions should result in productivity increases of at least 21 to 119%, compared to the "base" condition for Yakima populations (Table 9-18). Productivity is expected to increase the most for the Toppenish population (base to future = 33-119%). Productivity for the Upper Yakima, which has the largest survival gap in this MPG, is projected to increase 21-86% (base-future). For the other two populations, which also have survival gaps, productivity is expected to increase 21-100% for the Satus Creek population (tributary only) and 37-111% for the Naches population.

Abundance. The combined effects of current and future recovery actions should result in abundance increases of at least 26 to 2,558%, compared to the "base" condition for Yakima populations (Table 9-19). The largest increase in abundance is projected for the Upper Yakima population (base to future = 632-2,558%). Abundance for the Satus Creek population is projected to increase 26-130% (base-future). Abundance for the Toppenish and Naches populations should increase 55-185% and 185-547%, respectively.

Abundance/Productivity Risk. Under the major restoration scenario, all populations are expected to achieve ≤ 5% risk (in a 100-year time period) for abundance/productivity (Figure 9-4). Under

the minimum restoration scenario, however, only the Naches and Toppenish populations are projected to achieve ≤ 5% risk for abundance/productivity.

9.4 Summary of Expected Benefits of Proposed Actions for Middle Columbia Steelhead DPS

Based on the proposed actions identified within the specific management unit plans, all Middle Columbia River steelhead populations for which there are adequate data are expected to achieve less than 5% risk for abundance/productivity if the most intensive (major) restoration scenarios are implemented (Figure 9-5). Under minimum restoration scenarios, three populations (Deschutes Westside, Satus (tributary only), and Upper Yakima populations) may not achieve ≤ 5% risk for abundance/productivity. However, even under poor ocean conditions and minimum restoration actions, the abundance and productivity of these three populations are expected to increase considerably over base conditions (Tables 9-18 and 9-19).

Table 9-18 shows total changes in productivity of Middle Columbia River steelhead expected from current and prospective recovery actions. For Oregon populations and the Walla Walla and Touchet, total changes in productivity are based on benefits projected at ≤ 25 years into the future. The range of benefits represents performance of combined actions under relatively poor (-25%) and good (+25%) ocean conditions. Estimates greater than 1.00 result in higher productivity (e.g., 1.114 indicates an 11.4% increase in productivity, compared to the base period average); 1.00 indicates no change; and estimates less than 1.00 result in lower productivity.

Table 9-18. Total changes in productivity of Middle Columbia River steelhead expected from current and prospective recovery actions.

Major Population Group	Population	Total Base-to-Current	Total Current-to-Future (±25% Ocean)	Total Base-Current and Current-Future[1] (±25% Ocean)
Eastern Cascades	Deschutes W.[2]	1.114	1.179-1.957	1.313-2.180
	Deschutes E.[3]	1.111	1.767-2.919	1.963-3.243
	Klickitat[4]	1.085	1.047-1.375	1.136-1.492
	Fifteen Mile	1.077	1.276-2.128	1.374-2.291
	Rock Creek[5]	1.134	1.214	1.377
John Day	Lower Mainstem	1.151	1.340-2.131	1.542-2.452
	North Fork	1.149	1.134-1.870	1.303-2.149
	Middle Fork	1.151	1.376-2.252	1.584-2.592
	South Fork	1.150	1.165-1.920	1.340-2.209
	Upper Mainstem	1.150	1.541-2.504	1.771-2.879
Umatilla/Walla Walla	Umatilla	1.153	1.676-2.786	1.933-3.213
	Walla-Walla	1.194	1.613-2.688	1.925-3.209
	Touchet[6]	1.190	1.521-2.716	1.810-3.232
Yakima	Satus (tributary only)[7]	1.191	1.015-1.680	1.208-2.000
	Toppenish[7]	1.281	1.034-1.712	1.325-2.193

Major Population Group	Population	Total Base-to-Current	Total Current-to-Future (±25% Ocean)	Total Base-Current and Current-Future[1] (±25% Ocean)
	Naches[7]	1.196	1.142-1.761	1.366-2.107
	Upper Yakima[7]	1.193	1.015-1.562	1.211-1.862

[1] Calculated as the product of the Total Current-to-Future multiplier and the Total Base-to-Current multiplier.

[2] Represents the no passage and no stray action scenario.

[3] Represents the no stray action scenario.

[4] Represents actions without recolonization of the upper watershed.

[5] Benefits for Rock Creek steelhead were based on the FCRPS BiOp, which did not calculate survival changes under relatively good and poor ocean conditions.

[6] Base productivity for the Touchet population was estimated as the median of the empirical series of estimates for the Umatilla and Walla Walla populations. The base estimate for the Touchet is only a surrogate that will be replaced with an empirically derived estimate after there is a data series of sufficient length.

[7] Represents the minimum habitat restoration scenario.

Table 9-19 shows total changes in abundance of Middle Columbia River steelhead expected from current and prospective recovery actions. For Oregon populations and the Walla Walla and Touchet, total changes in abundance are based on benefits projected at ≤ 25 years into the future. The range of benefits represents performance of combined actions under relatively poor (-25%) and good (+25%) ocean conditions. Estimates greater than 1.00 result in higher abundance (e.g., 1.114 indicates an 11.4% increase in abundance, compared to the base period average); 1.00 indicates no change; and estimates less than 1.00 result in lower abundance. NA = information not available.

Table 9-19. Total changes in abundance of Middle Columbia River steelhead expected from current and prospective recovery actions.

Major Population Group	Population	Total Base-to-Current	Total Current-to-Future (±25% Ocean)	Total Base-Current and Current-Future[1] (±25% Ocean)
Eastern Cascades	Deschutes W.[2]	1.127	0.967-1.642	1.090-1.851
	Deschutes E.[3]	1.463	2.427-4.786	3.552-7.004
	Klickitat[4]	1.191	1.056-1.812	1.258-2.158
	Fifteen Mile	1.087	1.433-2.484	1.558-2.699
	Rock Creek[5]	NA	NA	NA
John Day	Lower Mainstem	1.346	2.083-4.012	2.804-5.401
	North Fork	1.207	1.173-2.096	1.417-2.531
	Middle Fork	1.218	1.346-2.374	1.640-2.892
	South Fork	1.216	1.171-2.111	1.425-2.568
	Upper Mainstem	1.240	1.737-3.083	2.155-3.824
Umatilla/Walla Walla	Umatilla	1.236	1.820-3.128	2.251-3.868
	Walla-Walla	1.329	2.353-4.010	3.128-5.331
	Touchet	1.248	1.574-3.623	1.965-4.523
Yakima	Satus (tributary only)[6]	1.285	0.982-1.786	1.261-2.296
	Toppenish[6]	1.435	1.080-1.987	1.550-2.851
	Naches[6]	2.057	1.387-3.145	2.854-6.470
	Upper Yakima[6]	4.271	1.714-6.223	7.318-26.576

[1] Calculated as the product of the Total Current-to-Future multiplier and the Total Base-to-Current multiplier.

[2] Represents the no passage and no stray action scenario.

[3] Represents the no stray action scenario.

[4] Represents actions without recolonization of the upper watershed.

[5] Benefits for Rock Creek steelhead were based on the FCRPS BiOp, which did not calculate survival changes under relatively good and poor ocean conditions.

[6] Represents the minimum habitat restoration scenario.

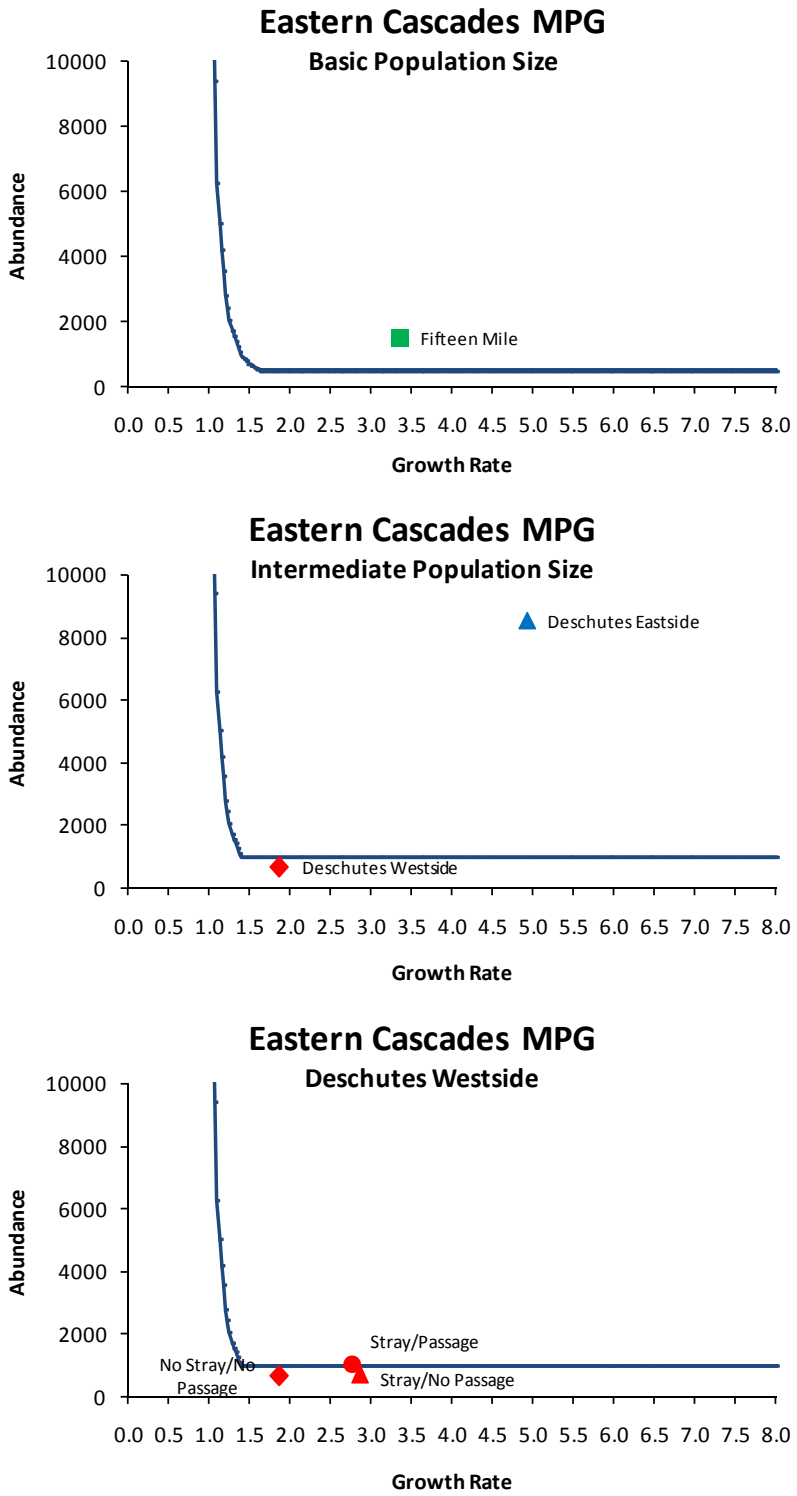


Figure 9-1. Relationship of projected abundance/productivity estimates to 5% risk curves (in a 100-year time period) for the different size steelhead populations within the Eastern Cascades MPG. In the top two graphs, estimated benefits (projected 25 years into the future) are associated with the least intensive restoration scenarios. The bottom figure shows the projected benefits associated with the different restoration scenarios for the Deschutes Westside population.

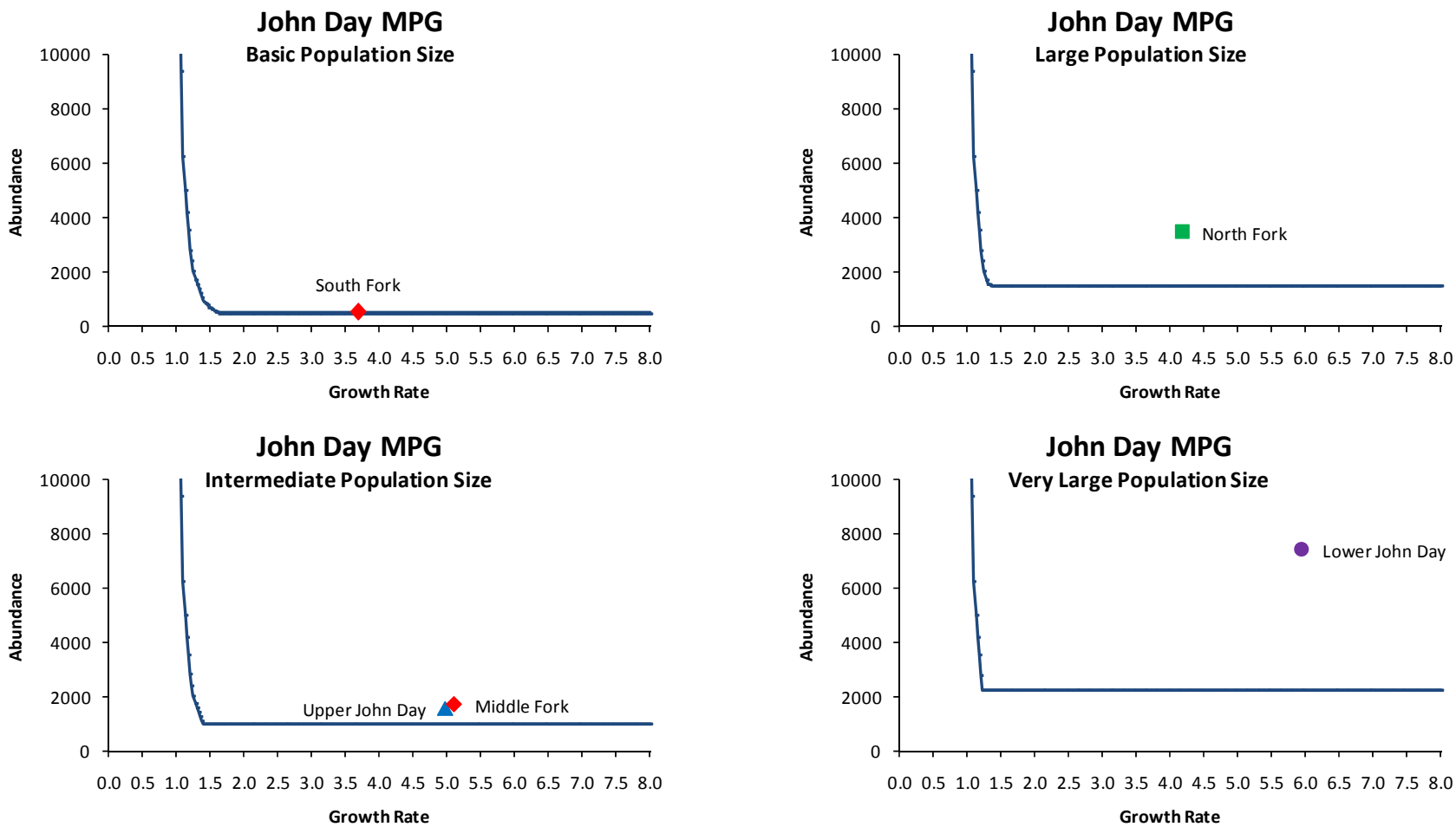
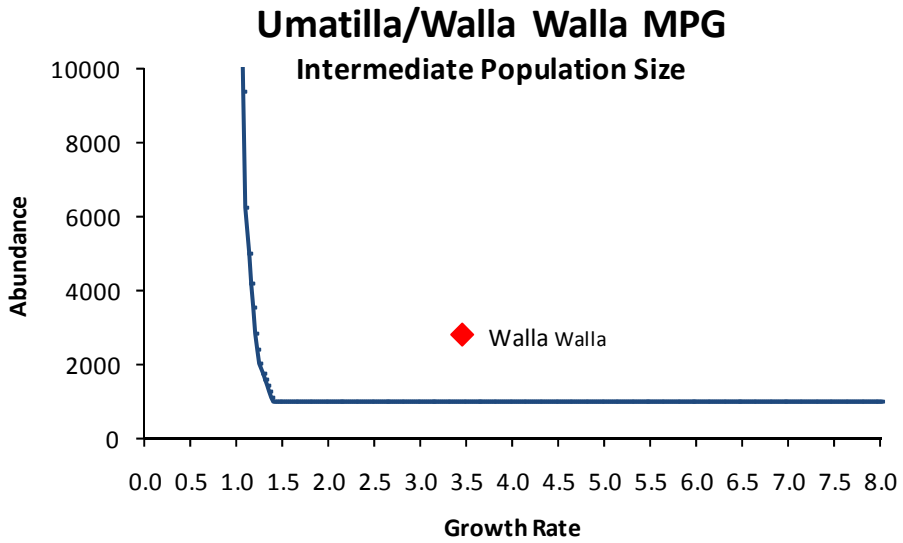


Figure 9-2. Relationship of projected abundance/productivity estimates to 5% risk curves (in a 100-year time period) for the different size steelhead populations within the John Day MPG. Estimates are projected at 25 years into the future. Populations are considered viable if the projected abundance/productivity estimates fall on or above the 5% risk curve.



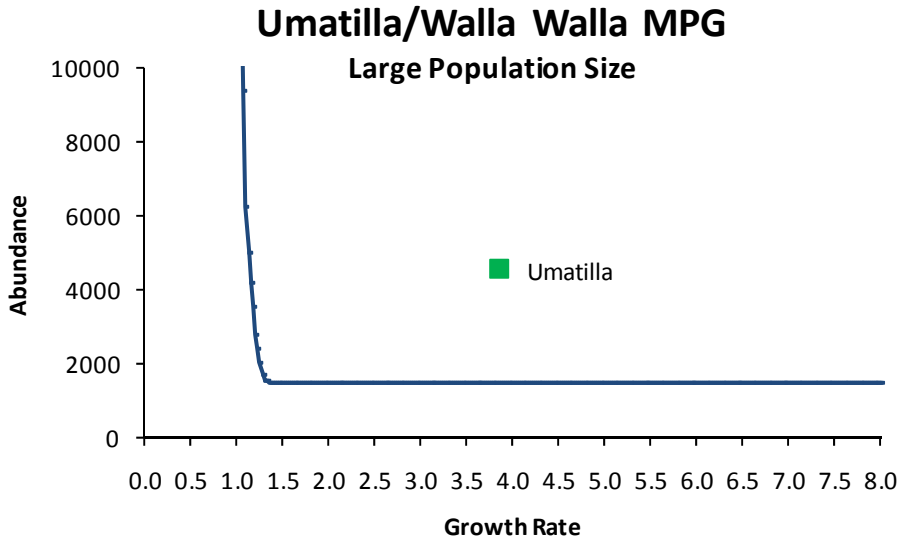


Figure 9-3. Relationship of projected abundance/productivity estimates to 5% risk curves (in a 100-year time period) for the different size steelhead populations within the Umatilla/Walla Walla MPG. The Walla Walla estimate includes restoration actions within both Oregon and Washington. Estimates are projected at 25 years into the future. Populations are considered viable if the projected abundance/productivity estimates fall on or above the 5% risk curve.

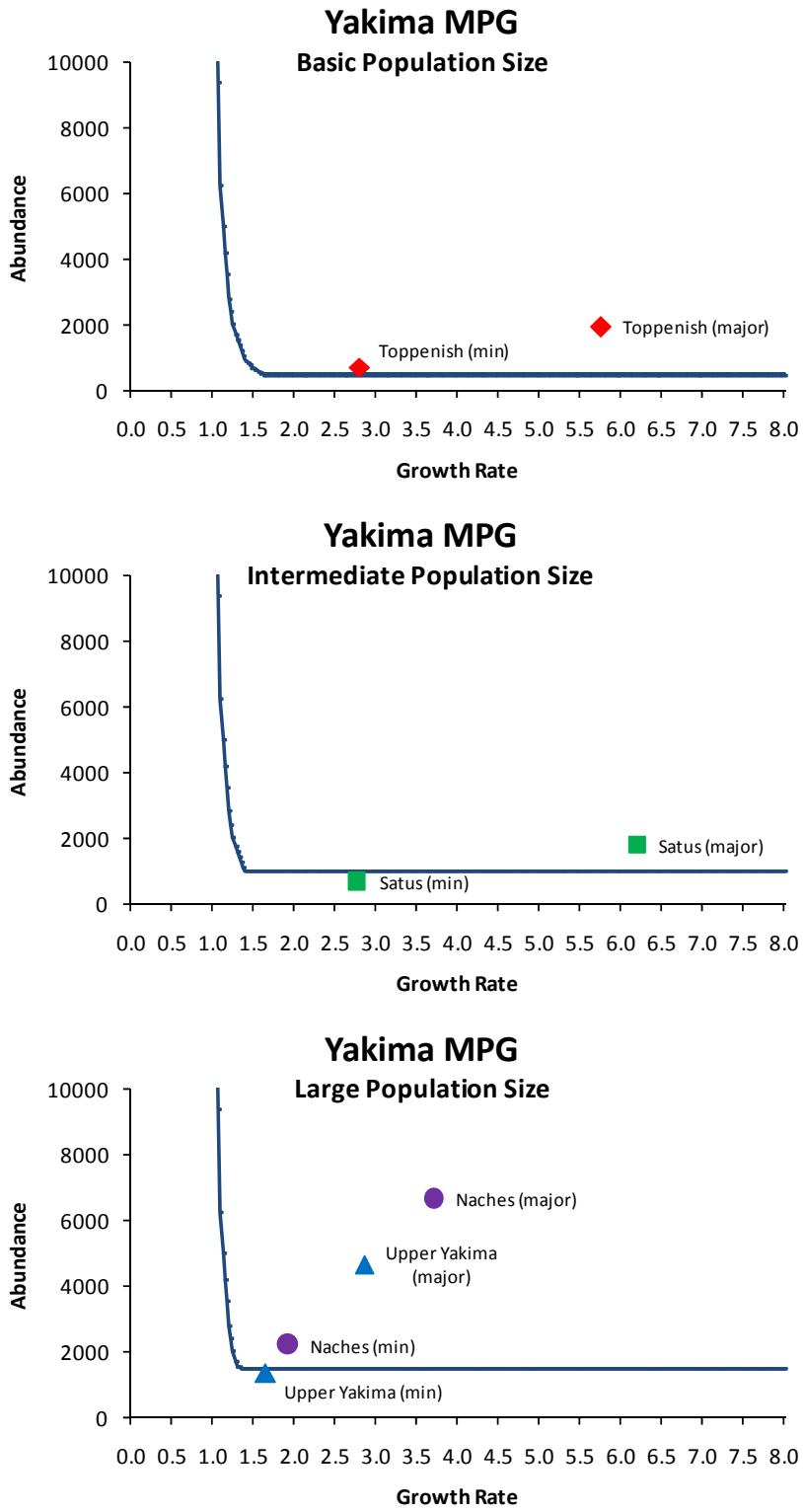


Figure 9-4. Relationship of projected abundance/productivity estimates to 5% risk curves (in a 100-year time period) for the different size steelhead populations within the Yakima MPG. Estimates from both minimum and major restoration actions are shown for each population. Populations are considered viable if the projected abundance/productivity estimates fall on or above the 5% risk curve.

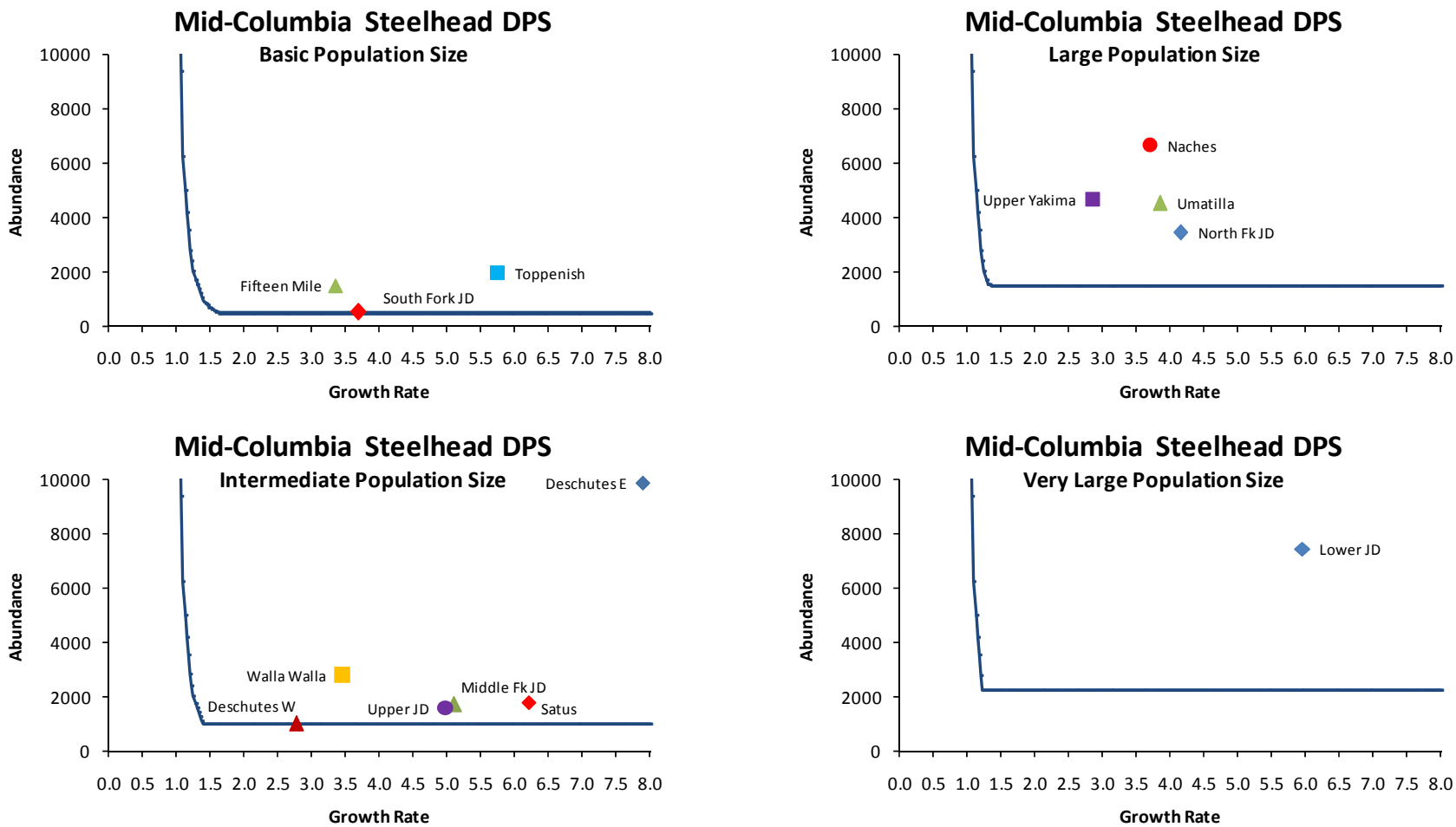


Figure 9-5. Relationship of projected abundance/productivity estimates to 5% risk curves (in a 100-year time period) for the different size steelhead populations within the Middle Columbia DPS. Estimates are projected at 25 years into the future and assume major restoration actions. Populations are considered viable if the projected abundance/productivity estimates fall on or above the 5% risk curve.

10. RESEARCH, MONITORING AND EVALUATION FOR ADAPTIVE MANAGEMENT

Because of the length and complexity of the salmonid life cycle and the habitat conditions these anadromous fish require, there are many uncertainties involved in improving salmon or steelhead survival. Simply identifying cause-and-effect relationships between any given management action and characteristics of fish populations can be a scientific challenge. It is essential to design a monitoring and evaluation program that will answer these basic questions: How will we know we are making progress? How will we get the information we need? And how will we use the information in decision making?

Within the Middle Columbia Basin, many different organizations, including Federal, state, tribal, local, and private entities, currently conduct programs and actions designed to improve tributary fish habitat, and these entities also conduct various kinds of monitoring. Development of Middle Columbia regional coordination will be essential for NMFS' future status reviews of the steelhead DPS. Establishing stable funding and staff to produce annual reports is also important.

Detailed research, monitoring, and evaluation (RM&E) and adaptive management plans need to be developed for each management unit, based on the principles and concepts laid out in the NMFS draft guidance document, *Adaptive Management for Salmon Recovery: Evaluation Framework and Monitoring Guidance* (http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/upload/Adaptive_Mngmnt.pdf). Each of the management unit Recovery Plans includes an RM&E component that follows or is generally consistent with the NMFS guidance document. The Oregon management unit plan is organized around a set of key RM&E questions applied to each MPG and includes a comprehensive set of recommendations addressing status monitoring, limiting factors assessments, and responses to recovery actions. The SE Washington management plan RM&E section is tailored after Washington state protocols, which share many of the principles included in the NMFS guidance document. The Yakima and Klickitat management unit plans explicitly incorporate the NMFS RM&E guidance principles and identify opportunities for improved status, limiting factors, and key uncertainty assessments. The Rock Creek Plan RM&E section recognizes that steelhead monitoring information has not been routinely collected in the basin and identifies a set of questions to inform monitoring implementation decisions. All of the management unit RM&E plans call for establishing a more detailed and specific RM&E implementation plan after the corresponding recovery plans are finalized.

The Middle Columbia Science Team will combine these management unit plans into an RM&E and adaptive management plan for the Middle Columbia steelhead DPS. This will ensure that, taken together, the monitoring and evaluation programs for each management unit, combined with monitoring components of the modules incorporated into the plans, address the needs of the entire DPS. The RM&E and adaptive management plans will be used by the Mid-C forum and others to guide projects and programs during implementation.

10.1 Designing a Monitoring and Evaluation Program to Support Adaptive Management for Recovery Plans

Adaptive management in salmon recovery planning is a method of decision making in the face of uncertainty. It is a process of adjusting management actions and/or directions based on new information. To do this, it is essential to incorporate a plan for monitoring, evaluation, and feedback into an overall implementation plan for recovery. The plan should link results (intermediate or final) to feedback on design and implementation of actions. Adaptive management works by coupling the decision-making process with collection of performance data and its evaluation. Most importantly, it works by offering an explicit process through which alternative strategies to achieve the same ends are proposed, prioritized, and implemented when necessary.

An adaptive management plan must include the following elements (Anderson, 2003):

- Management strategies that are revisited regularly;
- The use of conceptual or quantitative models of the system being managed to develop and test hypotheses and to guide strategy and action planning;
- A range of potential management actions that could be used to meet the strategy;
- Monitoring and evaluation to track progress;
- Mechanisms for incorporating learning from monitoring and evaluation into decisions on actions and strategies; and
- A collaborative structure for stakeholder participation in adjusting management strategies and actions.

Adaptive management is crucial for salmonid recovery programs because of the length and complexity of the salmonid life cycle and the uncertainties involved in improving salmonid survival and status. The key is to build explicit links between management actions, monitoring data, and biological and physical responses.

Several types of monitoring are needed to support adaptive management:

- Implementation and compliance monitoring, used to evaluate whether the recovery plan is being implemented.
- Status and trend monitoring, which assesses changes in the status of an ESU and its component populations, and changes in status or significance of the threats to the ESU.
- Effectiveness monitoring, which tests hypotheses on cause-and-effect relationships and determines (via research) if an action is effective and should be continued.

It is essential to build effectiveness monitoring into the implementation plan at the outset, because it requires explicitly coupling the monitoring design and implementation with the action design and implementation in order to detect an effect. Recovery plan implementation should consist of action strategies that include the demonstration of effect.

It is also important to explicitly address the many unknowns in salmon recovery – the “critical uncertainties” that make management decisions much harder. Critical uncertainty research may

seem expensive or unnecessary in light of basic information needs; however, in the long run, it will reduce monitoring and implementation costs.

Implementation and compliance monitoring simply check on whether activities were carried out as planned, and whether specified criteria are being met as a direct result of an implemented action. For example, if a fence is planned for 20 miles of stream corridor to keep livestock off the stream banks so that riparian vegetation will rebound, implementation monitoring would verify the presence of the fence. Compliance monitoring would take note of the presence or absence of livestock in the fenced-off area.

Status and trend monitoring is a simple compilation of data-based descriptions of existing conditions. To be useful in decision making, the raw data, or metrics, must be reduced to a more directly applicable form or indicator. For example, if the question is "What is the annual spawning population size of steelhead in the X River?" the indicator would be total spawning numbers of steelhead over one season for the entire river basin; however, the metric, or directly measured thing, would be something quite different, perhaps steelhead redds sighted on weekly passes over known spawning grounds. Thus, the metric must be processed to translate it from the metric data type (e.g., redds) into the indicator data type (e.g., spawners), and then reduced to generate the indicator required (e.g., list of weekly counts on spawning grounds to annual total for watershed).

Effectiveness monitoring specifically addresses cause-and-effect questions. Demonstrating the direct and indirect impact of management actions requires supporting all steps in the logical chain that connects the action to its expected impact. This chain is rarely short and usually contains several hypotheses. For this reason, it's better to build the effectiveness monitoring into the recovery action strategies, with, for example, pilot-scale tests or other methods carefully thought out beforehand. Monitoring and evaluation will only provide the answers to the questions they were designed to address; they do not provide the framework for revising these questions if they are ill-posed, evaluating the assumptions upon which the strategy was built, or incorporating learning into future decisions on actions and strategies—this is the role of adaptive management.

NMFS' guidance document presents a decision framework that can guide the design of a research, monitoring, and evaluation plan. The framework (Figure 10-1) contains two basic sorts of questions: (1) questions regarding ESU status (biological viability criteria) and (2) questions regarding statutory listing factors and factors limiting recovery (limiting factor and threats criteria). Evaluating a species for potential delisting requires an explicit analysis of both types of criteria.

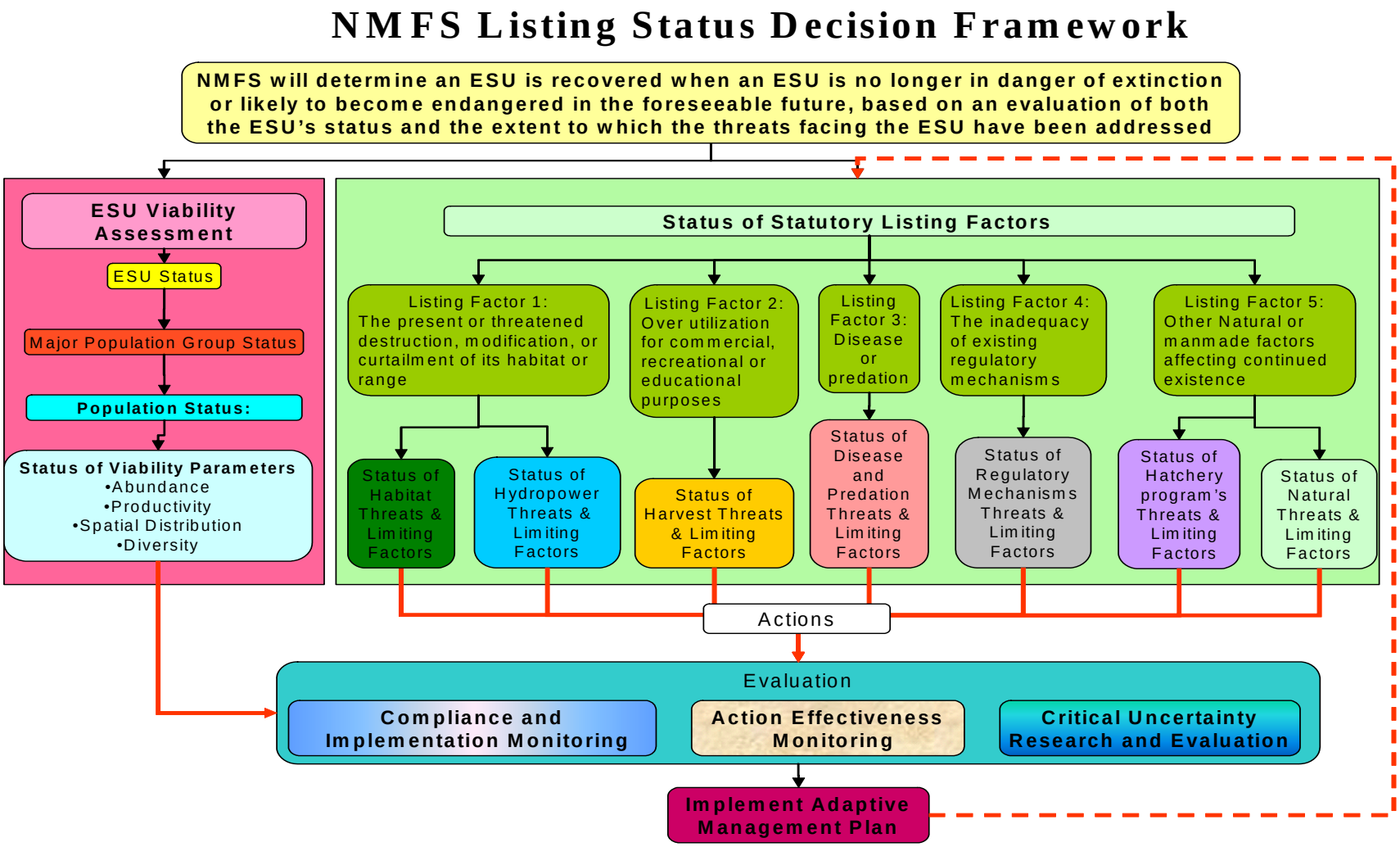


Figure 10-1. NMFS Listing Status Decision Framework

The guidance document contains a more detailed discussion of the framework and identifies the specific questions that must be answered to evaluate ESU status. These specific questions take the form of a series of decision-question sets that address the status and change in status of a salmonid ESU and the risks posed by threats to the ESU. The decision-question sets are designed to elicit the information NMFS needs to make delisting decisions. The framework can guide future decisions about strategies and actions aimed at achieving population, MPG, and ESU recovery goals.

Designing an effective monitoring program for salmon recovery involves the following initial steps:

1. Clarify the questions that need to be answered for policy and management decision making. Include the full ESU and the full salmonid life cycle.
2. Identify entity or entities responsible for coordinating development of this program.
3. Identify:
    - Which populations and associated limiting factors to monitor
    - Metrics and indicators
    - Frequency, distribution, and intensity of monitoring
    - Tradeoffs and consequences of these choices
4. Assess the degree to which existing monitoring programs are consistent with NMFS guidance.
5. Identify needed adjustments in existing programs, additional monitoring needs, and strategy for filling those needs.
6. Develop a data management plan (See Appendix C of the NMFS guidance document).
7. Prioritize research needs for critical uncertainties, testing assumptions, etc.
8. Identify entities responsible for implementation.

Monitoring and evaluation programs will provide (1) a clear statement of the metrics and indicators by which progress toward achieving goals can be assessed, (2) a plan for tracking such metrics and indicators, and (3) a decision framework through which new information from monitoring and evaluation can be used to adjust strategies or actions aimed at achieving the Plan's goals.

10.2 ESU/DPS Status Assessment and Adaptive Management

At five-year intervals, NOAA Fisheries Service will conduct status assessments of the Middle Columbia steelhead DPS. These status assessments will be based on the decision framework and will be informed by the information obtained through implementation of the monitoring, research, and evaluation programs in each management unit plan and the recovery modules. Similarly, adaptive management decisions at the management unit and module level will be informed by the status assessments as well as by recovery plan action implementation and effectiveness monitoring and associated research.

11. IMPLEMENTATION AND COORDINATION

This chapter describes how implementation of this recovery plan will be coordinated. It proposes that the Middle Columbia Recovery Forum (Mid-C Forum or Forum) will play a central role at the DPS-level.[43] The Forum is a voluntary organization of federal agencies, states, tribes and other planning entities (see Chapter 1), that will coordinate implementation within the DPS. The function, membership, processes and organization of the Forum are described herein. State entities will play a central role in coordination plan implementation at the MU level. This chapter also describes the Oregon and Washington approaches to recovery implementation and the role of NMFS.

NMFS' vision[44] for recovery implementation is that the actions identified in salmon and steelhead recovery plans are carried out in a cooperative and collaborative manner and that recovery and delisting occur. NMFS' strategic goals to achieve that vision are to:

1. Sustain local support and momentum for recovery implementation.
2. Implement recovery plan actions within the time periods specified in each plan.
3. Ensure that the actions implemented contribute to achieving recovery.
4. Provide accurate assessments of species status and trends, limiting factors, and threats.

NMFS' strategic approach to achieving these goals is to:

- Support local efforts by using Domain Teams[45] to coordinate (internally and externally) and encourage recovery plan implementation.
- Use recovery plans to guide internal and external regulatory decision-making.
- Use non-regulatory authorities and encourage others to use their authorities to implement recovery plans.
- Provide leadership to regional forums to develop research, monitoring, and evaluation (RME) processes that track action effectiveness and status and trends at the population and DPS levels.
- Provide periodic reports on species status and trends, limiting factors, threats, and plan implementation status.

NMFS will carry out its vision, goals, and strategic approach to recovery for Middle Columbia steelhead by working in partnership with the Mid-C Forum.

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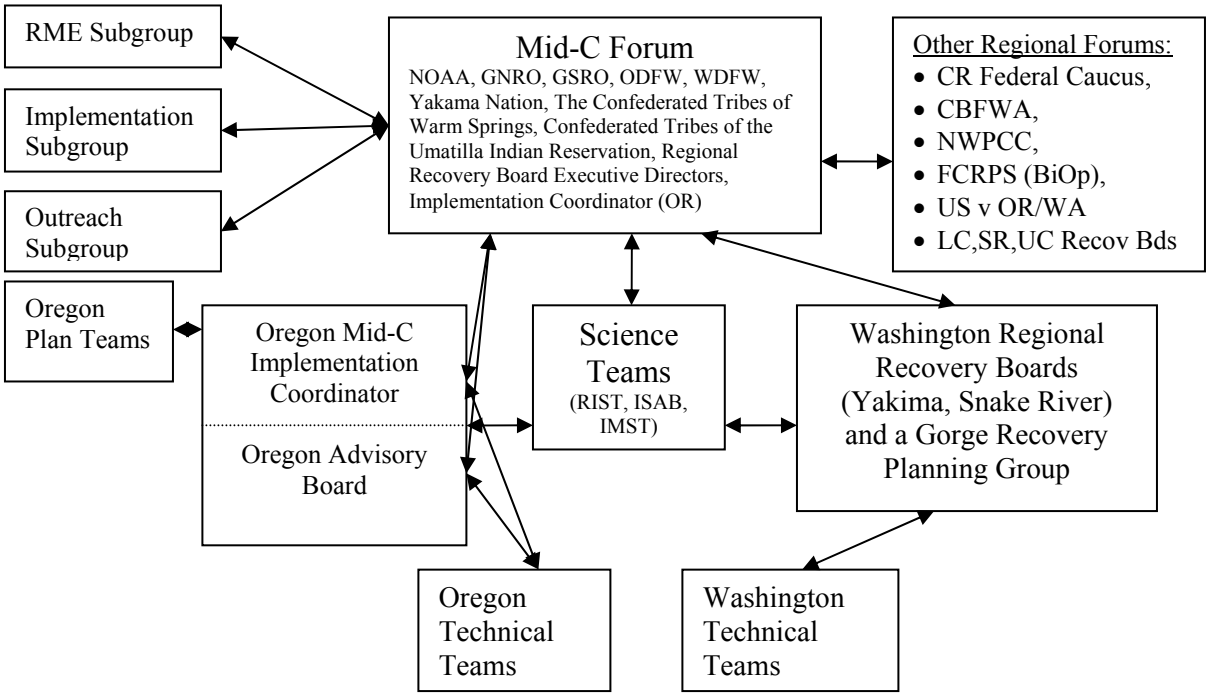
[43] The Mid-C Forum was formed in March, 2007 to assist NMFS in completing this recovery plan.
[44] From NOAA Fisheries Northwest Region Memo dated February 26, 2008, subject: Northwest Region Recovery Implementation Strategy.
[45] Domain Teams are an organizational structure internal to NMFS whose purpose is to coordinate recovery plan completion and the recovery implementation effort. The teams promote consistency in internal decision making and work with state, tribal, and local recovery parties to achieve recovery plan objectives.

11.1 Implementation Roles and Responsibilities

Effectively implementing recovery actions for Mid-C steelhead will require coordinating the actions of diverse private, local, state and federal parties spread across two states. In Washington, regional recovery boards have taken the lead on coordinating recovery implementation within the Yakima and Snake management units[46]. In Oregon, an implementation coordinator and reformed advisory board will be lead on recovery plan implementation, supported by the governance structure for the Oregon Plan for Salmon and Watersheds. Actions in the Columbia River, its estuary, and the ocean are implemented by a broad range of partners, including NMFS, the Bonneville Power Administration, the Bureau of Reclamation, the Army Corps of Engineers, federal land management agencies, state and tribal fisheries co-managers, the Columbia River Estuary Partnership, and local parties and jurisdictions interested in salmon recovery. The Mid-C Forum will take the lead in efforts to coordinate the actions of these many players at a DPS-level, supported by both local and regional Science Teams. Figure 11-1 gives an overview of the relationships between these entities.

Figure 11-1. Mid-C Recovery Plan Implementation Organizational Structure



[46] Implementation structures for the Eastern Cascades populations within Washington have yet to be determined.

11.1.1 Mid-C Forum

The Mid-C Forum provides organizational structure for communication and coordination on a bi-state and multi-tribal level across the entire DPS.

Specific functions include:

- Facilitating coordination and communication between federal agencies, states, and tribes.
- Advocating for the recovery of Mid-C steelhead.
- Promoting the application of adaptive management in the DPS.
- Providing recommendations for resource prioritization.
- Networking with other multi-jurisdictional Columbia recovery planning groups (e.g. Lower Columbia, Upper Columbia, and Snake River).
- Providing a scientific interface with the RIST.
- Coordinating and synthesizing RME efforts and activities.

The Forum will coordinate with broader efforts to develop common indicators for measuring trends. The Mid-C Forum may also identify legislative, congressional, and other funding opportunities for management actions and RM&E within the DPS. Policy issues will be resolved within respective local, state, federal and tribal authorities and agencies.

Organization/Membership:
The Mid-C Forum is guided by a Steering Committee. NMFS will serve as the convening partner and provide facilitation, venues, and guidance. Steering Committee membership includes management unit leads (or their representative) in Washington and Oregon and representatives from the Oregon and Washington governors' offices, NMFS, Yakama Nation, Confederated Tribes of Warm Springs, Confederated Tribes of the Umatilla Indian Reservation, Oregon Department of Fish and Wildlife, and Washington Department of Fish and Wildlife.

There is no established membership for participation in the broader activities of the Forum. It is anticipated that participation in regular Forum meetings, as distinguished from meetings of the Steering committee, will vary depending on the topics and issues being addressed.

Operations:
The Mid-C Forum and Steering Committee will conduct regular meetings semi-annually, or as needed, and work to reach consensus on issues of dispute or discrepancy within the DPS.

Functional Topics:
The Forum will focus on four functional topics. For each topic the Forum may establish subgroups to organize, implement, and track progress. The decision to establish such subgroups will be determined based on the anticipated scope of work for each functional topic, Forum members' available staffing and funding, and other considerations as the Forum considers appropriate. The intent of these efforts is to support coordinated and effective implementation of the Mid-C Steelhead Recovery Plan and to ensure that 5-year status reviews by NMFS are informed and efficient. The four functional topics are:

1. Research, Monitoring & Evaluation: RM&E will be coordinated by a Science Team which will be comprised of RIST representatives (current ICTRT members), management unit technical representatives, ODFW/WDFW/tribal co-manager technical representatives, etc. Focus areas may include:

    - Review/compile new information on VSP parameters and update stock status summaries accordingly.

    - Identify knowledge gaps that are high priorities across the DPS and review/coordinate efforts to address them.

    - Identify how to track threats criteria and provide annual summaries of applicable data.

    - Develop a DPS monitoring and evaluation and adaptive management plan.

2. Implementation: Subgroups may be comprised of key project managers from management units, representatives from key funding programs (NMFS Restoration programs, Council, SRFB, etc), and key partners in recovery actions (USFS, BOR, others). Its focus areas may include:

    - Review status of implementation scheduling for each management unit.

    - Share significant accomplishments by management units.

    - Promote technology transfer relevant to implementation across management Units.

    - Communicate priorities for future actions to assist coordination across management units.

    - Identify opportunities where shared advocacy and coordination help implement key recovery actions (e.g., combine suitable proposals into single programmatic proposal; share technical resources for design review, etc).

3. Outreach: Subgroups may be comprised of representatives from state governors' staffs, co-manager policy leads, management unit representatives, and/or partner agency policy people. Its focus area is to develop/support outreach related to Mid-C recovery including reviewing/drafting NMFS two-year reports and updates to key decision makers (elected officials, agency heads, etc).

4. Policy: Policy issues will be managed by the Steering Committee, who may elect to organize subgroups for specific issues. Policy focus areas include:

    - Identify issues where joint advocacy supports Mid-C recovery action.

- Track the status of Mid-C related activities in the Power and Conservation Council, Federal Caucus, FCRPS litigation, U.S. vs. OR, U.S. vs. WA and other regional forums.

- Identify and, if appropriate, develop Mid-C policy proposals.

11.1.2 Management Unit Leads

The proposed organizational structure for plan implementation within Oregon and Washington is based on the structure used for development of the respective management unit recovery plans, with the note that these approaches differed, and will continue to differ, slightly. In Oregon, the Department of Fish and Wildlife (ODFW) led recovery plan development with assistance from the Governor's Natural Resources Office and NMFS. For implementation of the Oregon management unit recovery plan ODFW will seek an additional staff person (Implementation Coordinator) to facilitate implementation. In Washington, regional recovery boards, where they exist, developed the management unit plans and will coordinate plan implementation with guidance and support from the Governor's Salmon Recovery Office.

For the purposes of implementation, the term "management unit leads" (MU leads) refers to the Washington regional recovery boards, Oregon's recovery plan Implementation Coordinator (in conjunction with an Advisory Board) and, where no recovery board exists in Washington, NMFS. The MU leads have three primary responsibilities in regard to tributary-based implementation. Performance of these responsibilities will be influenced by MU lead capacity, authority, and MU priority, and will likely require other support structures or processes to fully accomplish these responsibilities. Not all of these duties can be accomplished initially with the current resources available. Prioritization of the initial duties will be guided by the statutory requirements of the ESA and the individual state's guidance.

The first responsibility for MU leads is to coordinate and develop implementation schedules for the respective MUs. Implementation schedules identify the following:

- Recovery actions specific to populations within the MUs.
- Limiting factor(s) addressed by each action.
- Priority for completing the actions.
- Duration of and schedule for actions.
- Benefits of the action(s).
- Lead agency/entity to implement each population-specific action.
- Estimated cost for each action over a period of time.

The second responsibility for MU leads is to coordinate implementation of recovery actions identified in the plan and implementation schedule. In this regard, they serve to facilitate two-way communication vertically (i.e., different spatial scales related to recovery plan governance) and horizontally (i.e., related programs, interests, and oversight outside of recovery plan governance)

within their respective inter- and intra-agency organizational structures. Specific responsibilities include:

- Coordinate with federal and state agencies, tribes, local government, and other stakeholders, with an emphasis on implementing tributary habitat actions.
  - Coordinate development of implementation strategies for voluntary actions requiring complex coordination among various entities to complete, including:
    - local outreach,
    - incentives,
    - technical help,
    - project funding,
    - project management, and
    - Monitoring/reporting.

- Coordinate plan research within the MU.
  - Include results and reports in system information/outreach materials.

The third responsibility for MU leads is to track and report on progress of implementation in accordance with state and federal reporting requirements. Specific responsibilities include:

- Coordinate plan monitoring within the MU.
  - Ensure appropriate tracking and reporting of recovery actions.

- Report on plan progress in relation to goals, strategies, and actions, using mechanisms and processes established for tracking progress.
  - Highlight plan successes and needs.

- Review and revise implementation schedules as necessary.
  - Use monitoring and research to guide actions.
  - Incorporate adaptive management, as needed.

- Represent the MU in the Mid-C Forum and Forum subgroups, as necessary.

11.1.3 Washington Regional Recovery Boards

Purpose and Function:
Regional Recovery Boards will be the MU Leads in Washington, and will serve those functions described under Section 11.1.2. In general, this entails overseeing, promoting, coordinating, and tracking actions and RM&E efforts within their respective management units (or within units that span two states) to ensure implementation of the Middle Columbia recovery plan. In addition, the Boards will coordinate data acquisition and sharing, seek funding opportunities for specific management unit actions, and track and ensure progress reporting to the Mid-C Forum on viability and threat trends for steelhead.

Regional Recovery Boards' regular operations are served by Executive Directors. The directors will coordinate Regional Recovery Board efforts, with assistance from the Governor's Salmon Recovery Office. Yakama Nation management and policy-level staff and other participants will coordinate with NMFS in areas not covered by a Recovery Board.

Organization/Membership:
Regional Recovery Boards include the Yakima Basin Fish and Wildlife Recovery Board, and the Snake River Salmon Recovery Board. The Columbia Gorge management unit will be served by the Yakama Nation and other participants NOAA brings into the recovery process. Where boards are in place, they are comprised of government and tribal representatives and other local interests and are funded through the Washington Salmon Recovery Funding Board.

Operations:
Washington Regional Recovery Boards meet regularly, generally monthly or quarterly. Progress reporting will be done in coordination with existing "support" teams of Board and state/federal/tribal agency staff.

The Yakima Basin and Snake River boards will report progress to the Mid-C Forum annually, including progress in management, conservation and RM&E actions, and trends in habitat health and salmonid viability.

Resources:
Washington's Recovery Boards will operate on existing funding sources.

11.1.4 Oregon Implementation Coordinator and Advisory Board

Implementation Coordinator:
The Implementation Coordinator will serve as Oregon's MU Lead, under advice from the Advisory Board, and will interface horizontally with state agencies and teams associated with the Oregon Plan for Salmon and Watersheds (OPSW) governance structure (including the Central Regional Management Team, Monitoring Team, Outreach Team, and Oregon Plan Core Team chaired by Governor's Natural Resources Office), as well vertically with plan implementers, Oregon's Mid-C Advisory Board, Mid-C Forum, and associated teams and subgroups.

Advisory Board Purpose and Function:
The Advisory Board's general objective will be to advise the Implementation Coordinator and help the Implementation Coordinator and other implementers address inter-entity coordination needs necessary for implementation of the recovery plan at the MU, MPG, and population levels. This includes: a) assisting the Implementation Coordinator in the development of follow-up recovery plan documents (e.g., implementation plans and schedules, periodic reports, and recovery plan revisions or adaptive management actions), b) providing coordination, consistency, and support within the MU regarding implementation actions, c) serving as a conduit of information to and from the entities, agencies, or constituencies which each member represents, other members of the Board, and the Implementation Coordinator, and d) assisting in resolving other implementation issues as they arise.

Organization/Membership:
The Oregon Mid-C Advisory Board will be comprised of members of the Mid-C Stakeholder (Sounding Board) and planning teams which were formed for recovery plan development, as well as the Implementation Coordinator. Advisory Board members will include local stakeholder interests and interest groups and federal, state, local, and tribal representatives. Members will represent a broad mix of entities and geographic (i.e., MPG) areas.

Operations:
The Advisory Board will elect a Chair from its members at intervals determined by the Advisory Board. The Advisory Board will likely meet at least annually. The Board, or sub-committees of the Board, will meet more frequently as is necessary for development of specific products.

In addition to being a member of the Advisory Board, the Implementation Coordinator will serve as staff for the Board. This will entail coordinating meetings, developing meeting notes, following up on meeting actions, and representing the Board on the Mid-C Forum. The Implementation Coordinator will also be responsible for coordinating recovery plan needs (i.e., responsibilities for the plan listed in Section 11.1.2. Management Unit Leads) with the Advisory Board. The Implementation Coordinator may serve as the Advisory Board's Chair, if elected. The Implementation Coordinator will also interface with other "implementers" in Oregon's management unit that are not members of the Advisory Board, as well as the Oregon Plan teams to ensure effective coordination and communication on monitoring, management and policy issues, and action implementation.

Resources:
Oregon's Implementation Coordinator would be a new position within the Oregon Department of Fish and Wildlife. Funding is currently being pursued for this position. Members of the Oregon Advisory Board will not receive any additional funding for service on the Board.

11.1.5 NMFS

NMFS' role in Middle Columbia steelhead recovery is twofold. The first is to ensure that the agency's statutory responsibilities for recovery under the ESA are met. In this capacity, NMFS is responsible for:

- Ensuring the recovery plan meets ESA statutory requirements, tribal trust and treaty obligations, and agency policy guidelines.
- Developing DPS-wide performance measures consistent with the recovery strategy outlined in Chapter 7.
- Conducting 5-year status reviews.
- Making delisting determinations.
- Coordinating with other federal agencies to ensure compliance under the ESA.

The second is to serve as the convening partner for the Mid-C Forum. In this capacity, the NMFS' Northwest Regional Office, working through its Middle Columbia Recovery Coordinator and Domain Team, will:

- Convene Forum meetings on a regular basis (2 times per year) and convene additional meetings as needed
- Provide meeting facilitation services and manage the meeting process.
- Provide Forum meeting venues.

- Prepare and distribute meeting notes and follow up on tasks agreed to by the Forum.
- Serve as central clearing house for information, to include: DPS-wide stock status, relevant federal scientific research, and DPS-wide gaps in recovery efforts.
- As requested by the Forum, establish and facilitate state, federal and tribal meetings necessary for the coordination of recovery activities.

11.1.6 Technical Teams

Purpose and Function:
Technical teams are ad hoc work units or groups associated with supporting on-the-ground implementation of actions, monitoring and research, or technical analysis of data. The teams are a part of the foundation of implementation**.**

Organization/Membership:
Technical Teams are comprised of the members or staff of various watershed councils, soil and water conservation districts, non-governmental organizations, state agencies, federal agencies, tribes, and others that conduct recovery plan actions, research, monitoring, or evaluation in the field or in the lab.

Operations:
"Teams" operate within their own internal structures, but will be requested to provide information and data to their respective MU Lead to ensure appropriate tracking and coordination within management units.

11.1.7 Science Team

Purpose and Function:
The Science Team will provide science input and advice to Mid-C actions, strategies, research designs, and RM&E priorities, including scoping science needs from RM&E needs at the MU and DPS-level. The Science Team will ensure that rigorous and "best available science" informs implementation and is applied in RM&E for all "H's" within the DPS, and assist in translating information into status of species viability. The Science Team's input will be critical to 5-year reviews of the DPS.

Organization/Membership:
The Science Team will be a standing committee of the Forum and will be comprised of RIST representatives (current ICTRT members), management unit technical representatives, ODFW/WDFW/tribal co-manager technical representatives, etc. The Science Team will select its own chair. It will coordinate with existing groups (e.g., the Recovery Implementation Science Team (RIST), Independent Science Advisory Board (ISAB), and/or the Independent Multidisciplinary Science Team (IMST)) or groups formed to provide scientific expertise for a specific purpose.

Operations:
The Science Team will operate on an ad hoc basis or on a regular schedule as determined by its members and will provide science oversight and guidance to the full DPS or to each management unit, as needed. The Science Team will coordinate with management unit technical teams where necessary.

11.2 Funding and Resources

11.2.1 Implementation Funding

Funding for project implementation is available from a variety of sources. The role of the Forum is to ensure MU plan implementers are aware of potential sources of funds and to advocate for the funding and implementation of actions that benefit all populations in the DPS. The Forum will not supersede decisions made by the individual management unit boards but may advocate for the funding of their projects and programs if requested.

Sources of implementation funding include:

- Pacific Coastal Salmon Recovery Fund (PCSRF) (States and tribes).
- Salmon Recovery Funding Board (SRFB) (Washington).
- Oregon Watershed Enhancement Board (OWEB) (Oregon).
- Congressional appropriations (Federal agencies).
- State appropriations (State agencies).
- Northwest Power and Conservation Council Fish and Wildlife Program (States and tribes).
- Federal / state grants.
- Non-profit organization programs and grants.

11.2.2 Funding for Mid-C Forum Activities

Staff time for participation in the Mid-C Forum is to be funded by participating agencies and parties. NMFS will fund venues, facilitation, and other needs associated with convening Mid-C Forum meetings.

12 BIBLIOGRAPHY

Araki, H., B. Cooper and M.S. Blouin. 2007. Genetic effects of captive breeding cause a rapid, cumulative fitness decline in the wild. Science, 318: 100-103.

Bambrick, D., T. Cooney, B. Farman, K. Gullett, L. Hatcher, S. Hoefer, E. Murray, R. Tweten, R. Gritz, P. Howell, K. McDonald, D. Rife, C. Rossel, A. Scott, J. Eisner, J. Morris and D. Hand. 2004. Critical Habitat Analytical Review Team (CHART) Assessment for the Middle Columbia River Steelhead ESU. – Incomplete ref.

Beechie, T. and S. Bolton. 1999. An approach to restoring salmonid habitat-forming processes in Pacific Northwest watersheds. Fisheries, 24:4:6-15. April 1999.

Beechie, T., G. Pess, P. Roni, and G. Giannico. 2007 In Press. Setting river restoration priorities: a review of approaches and a general protocol for identifying and prioritizing actions. North American Journal of Fisheries Management.

Behnke, R.J. 1992. Native trout of western North America. Am. Fish. Soc. Monog. 6, 275 p. American Fisheries Society, Bethesda, Maryland.

Berejikian, B. and M.J. Ford. 2004. Review of relative fitness of hatchery and natural salmon. National Oceanic and Atmospheric Administration technical memorandum NMFS-NWFSC-61. Northwest Fisheries Science Center, Seattle. Available from http://www.nwfsc.noaa.gov/publications

Burgner, R.L., J.T. Light, L. Margolis, T. Okazaki, A. Tautz and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific ocean. Bulletin No. 51, International North Pacific Fisheries Commission, Vancouver, British Columbia, Canada.

Busby, P. J., T. C. Wainwright, E. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum 27.

Carmichael, R. 2007. Draft Oregon Mid-Columbia River Steelhead Recovery Plan. November 2007. Oregon Department of Fish and Wildlife.

Chilcote, M.W. 2001. Conservation Assessment of Steelhead Population in Oregon. March 5, 2001 Public Review Draft. Oregon Department of Fish and Wildlife, Portland, OR. 83 pp.

Crozier, L. and R.W. Zabel. 2006. Climate impacts at multiple scales: evidence for differential population responses in juvenile Chinook salmon. Journal of Animal Ecology (2006) 75:1100–1109.

Crozier, L., R.W. Zabel, and A.F. Hamlet. 2008. Predicting differential effects of climate change at the population level with life-cycle models of spring. Global Change Biology (2008) 14:236–249

Fleming, I.A. and E. Peterson. 2001. The ability of released hatchery salmonids to breed and contribute to the natural productivity of wild populations. Nordic Journal of Freshwater Research 75:71-98

Good, T. P., R.S. Waples, and P. Adams (editors). 2005. Updated status of Federally listed ESUs of West Coast salmon and steelhead. U.S. Commerce., NOAA Technical Memo. NMFS-NWFSC-66, 598p. Available at http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/upload/SR2005-allspecies.pdf

Hooton, R. 1987. Catch and release as a management strategy for steelhead in British Columbia. In R. Barnhart and T. Roelofs, eds, Proceedings of catch and release fishing, a decade of experience. September 30 - October1, 1987. Humboldt State University, Arcata, CA.

Independent Scientific Advisory Board (ISAB). 2007. Climate Change Impacts on Columbia River Basin Fish and Wildlife. ISAB Climate Change Report, ISAB 2007-2. May 11, 2007.

Independent Scientific Advisory Board (ISAB). 2008. Non-native Species Impacts on Native Salmonids in the Columbia River Basin. ISAB 2008-4. July 15, 2008.

Interior Columbia Technical Recovery Team (ICTRT). 2005. Interior Columbia Basin TRT: Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. ICTRT Internal Review Draft. July 18, 2005.

Interior Columbia Technical Recovery Team (ICTRT). 2007a. Viability Criteria for Application to Interior Columbia Basin Salmonid ESUs. Review draft March 2007. Available at: http://www.nwfsc.noaa.gov/trt/trt_viability.cfm

Interior Columbia Technical Recovery Team (ICTRT). 2007b. Draft stock status assessments, in preparation.

Interior Columbia Technical Recovery Team (ICTRT). 2007c. Required Survival Rate Changes to Meet Technical Recovery Team Abundance and Productivity Viability Criteria for Interior Columbia River Basin Salmon and Steelhead Populations. ICTRT Review Draft. Nov. 30, 2007.

Interior Columbia Technical Recovery Team (ICTRT). 2008. Current Status Reviews: Interior Columbia Basin Salmon and Steelhead ESUs. Volume III: Middle Columbia River SteelheadDistinct Population Segment (DPS). Draft, May 9, 2008.

Leider, S. A., M. W. Chilcote, and J. L. Loch. 1986. Comparative life history characteristics of hatchery and wild steelhead trout (*Salmo gairdneri*) of summer and winter races in the

Kalama River, Washington. Canadian Journal of Fisheries and Aquatic Sciences 43:1398–1409.

McClure, M. M., E. E. Holmes, B. L. Sanderson, and C. E. Jordan. 2003. A large-scale, multi-species status assessment: Anadromous salmonids in the Columbia River basin. Ecol. Appl. 13(4):964–989.

McClure, M., T. Cooney and the Interior Columbia Technical Recovery Team. 2005. Updated population delineation in the Interior Columbia Basin. Memo to NMFS NW Regional Office, Co-managers and other interested parties. May 11, 2005. National Marine Fisheries Service. Seattle, Washington.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-42, 156 p.

McElhany, P. T., Backman, C. Busack, S. Heppell, S. Kolmes, A. Maule, J. Myers, D. Rawding, D. Shively, A. Steel, C. Steward and T. Whitesel. 2003. Draft Willamette/Lower Columbia Pacific Salmonid Viability Criteria. March 2003.

McGinnity, P., et al. 2003. Fitness reduction and potential extinction of wild populations of Atlantic salmon, Salmo salar, as a result of interactions with escaped farm salmon. Proceedings of the Royal Society of London Series B: Biological Sciences 270:2443-2450.

Mongillo, P.P. 1984. A summary of salmonid hooking mortality. Fish Management Division. Washington Department of Game.

Myers, R.A., S.A. Levin, R. Lande, F.C. James, W.W. Murdoch, and R.T. Paine. 2004. Ecology. Hatcheries and endangered salmon. Science 303:1980.

Narver, D.W. 1976. Stream management for west coast anadromous salmonids. Pages 7-13 in Stream management of salmonids. -Trout, Winter 1976 Suppl.

NMFS (National Marine Fisheries Service). 1996. Making Endangered Species Act determinations of effect for individual or grouped actions at the watershed scale. The National Marine Fisheries Service Environmental and Technical Services Division, Habitat Conservation Branch, Seattle, WA.

National Marine Fisheries Service (NMFS). 1999a. Updated Review of the Status of the Upper Willamette River and the Middle Columbia River ESUs of Steelhead (Oncorhynchus mykiss). January 12, 1999, NMFS-NWFSC Status Review Update Memo, Available on the Internet at: http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/upload/SR1999-steelhead.pdf

National Marine Fisheries Service (NMFS). 1999b. Evaluations of the Status of Chinook and Chum Salmon and Steelhead Hatchery Populations for ESUs Identified in Final Listing Determinations. March 4, 1999, NMFS-NWFSC Status Review Update Memo. Available on the Internet at: http://www.nwr.noaa.gov/1salmon/salmesa/pubs/sru990304.pdf

National Marine Fisheries Service (NMFS). 2004. Initial Assessment of NMFS' Critical Habitat Analytical Review Teams (CHARTs) for 13 Evolutionarily Significant Units of Pacific Salmon and *O. mykiss* (November 2004), including Appendix K: Initial CHART Assessment for the Middle Columbia River Steelhead.

National Marine Fisheries Service (NMFS) 2005a. Final Assessment of NOAA Fisheries' Critical Habitat Analytical Review Teams for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead. August 2005.

National Marine Fisheries Service (NMFS) 2005b. Endangered and Threatened Species; Designation of Critical Habitat for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead in Washington, Oregon, and Idaho. September 2, 2005, Federal Register/ VOL 70, No. 170.
Available on the Internet at:
http://www.nwr.noaa.gov/Salmon-Habitat/Critical-Habitat/NWR-CH-Designation-FRN.cfm

NMFS 2006. Draft Recovery Plan Module for Mainstem Columbia River Hydropower Projects ("Hydro Module"). NMFS Northwest Region. Portland, Oregon.

National Marine Fisheries Service (NMFS). 2007. Columbia River Estuary ESA Recovery Plan Module for Salmon and Steelhead. November 5, 2007. available at http://www.nwr.noaa.gov/Salmon-Recovery-Planning/ESA-Recovery-Plans/Estuary-Module.cfm

NMFS (National Marine Fisheries Service). 2008a. Endangered Species Act – Section 7 Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Consultation: consultation on remand for operation of the Columbia River Power System and 19 Bureau of Reclamation Projects in the Columbia Basin. ("FCRPS BiOp") NMFS, Portland, Oregon.

NMFS. 2008b. Biological Opinion: Impacts of US v OR Fisheries in the Columbia River in years 2008-2017 on ESA listed Species and Magnuson-Stevens Act Essential Fish Habitat. May 5, 2008. Available at https://pcts.nmfs.noaa.gov/pls/pcts-pub/pcts_upload.summary_list_biop?p_id=107547

Oregon Department of Fish and Wildlife (ODFW). 2008. Conservation and Recovery Plan for Oregon Steelhead Populations in the Middle Columbia River Steelhead Distinct Population Segment. August 2008.

Rawding, D. 2000. A methodology for estimating the adult winter steelhead sport fishing mortality in tributaries to the Lower Columbia River. Washington Department of Fish and Wildlife. Vancouver, WA Unpublished draft, 18pp.

Reingold, M. 1975. Effects of displacing, hooking, and releasing on migrating adult steelhead trout. Trans. Amer. Fish. Soc. 104(3):458-460.

Roelofs, T.D. 1983. Current status of California summer steelhead (*Salmo gairdneri*) stocks and habitat, and recommendations for their management. Submitted to USDA Forest Service, Region 5, 77 p. (Available from Protected resources Division, National Marine Fisheries Service, 1201 E Lloyd Blvd., Suite 1100, Portland, Oregon 97232.)

Roni, P., T.J. Beechie, R.E. Bilby, F. E. Leonetti, M.M. Pollock, and G.R. Pess. 2002. A review of stream restoration techniques and a hierarchical strategy for prioritizing restoration in Pacific Northwest watersheds. North American Journal of Fisheries Management, 22(1):1-20.

Roni, Phil, Karrie Hanson, Tim Beechie, George Pess, and Michael Pollock. 2005. Habitat rehabilitation for inland fisheries: global review of effectiveness and guidance for rehabilitation of freshwater ecosystems. FAO Fisheries Technical Paper 484. FAO, Rome.

Shapovalov, L. and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri*) and silver salmon *(Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Calif. Dept. Fish and Game, Fish Bull. No. 98. 373 pp.

Waples, R. S., R. P. Jones, Jr., B. R. Beckman, and G. A. Swan. 1991. Status review for Snake River fall Chinook salmon, United States Department of Commerce, National Oceanic and Atmospheric Administration.

Ward, B. R., and P. A. Slaney. 1988. Life history and smolt-to-adult survival of Keogh River steelhead trout *(Salmo gairdneri).* Canadian Journal of Fisheries and Aquatic Sciences 45:1110-1122.

Washington Department of Fish and Wildlife (WDFW). 2008. Fisheries Management and Evaluation Plan. Mid-Columbia River Region. Prepared by Washington Department of Fish and Wildlife. April 7, 2008. Olympia, WA.

Withler, R. E. 1988. Genetic consequences of fertilizing chinook salmon (*Oncorhynchus tshawytscha*) eggs with pooled milt. Aquaculture 68: 15-25.

Yakama Indian Nation (YIN) and WDFW. 2008. Draft Klickitat River Anadromous Fisheries Master Plan. Yakima/Klickitat Fisheries Project 1988-115-35. Toppenish, WA.